OCR GCSE (J277)

Module K: Algorithm design

Workbooklet · 8 parts · 166 marks

K4 is IGCSE (Cambridge) only and not on J277.

Contents

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	Total	**166**

MODULE K ALGORITHM DESIGN · K1

Abstraction, decomposition, algorithmic thinking, and inputs, processes and outputs

Original practice questions · 20 marks · ~25 minutes · OCR J277 spec 2.1.1, 2.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

Abstraction, decomposition and algorithmic thinking are principles of computational thinking.

(a) State what is meant by **abstraction**. **[1]**

(b) State what is meant by **decomposition**. **[1]**

(c) State what is meant by **algorithmic thinking**. **[1]**

2

Total: 4 marks

A city bike-hire company is designing a map for its phone app. Riders use the map to find the nearest docking station that has a bike they can hire, and to plan a route along the city's cycle lanes. Abstraction is used to decide what the map shows.

(a) Identify **two** details that the map needs to show. **[2]**

(b) Identify **two** details that can be left out of the map. **[2]**

3 **Total: 6 marks**

A delivery company has parcel lockers in town centres. A program controls each set of lockers. When a courier arrives, they scan the barcode on the parcel and enter the size of the parcel (small, medium or large). The program searches for an empty locker of that size and creates a random six-digit collection code for the parcel. The door of the chosen locker then opens and the screen shows the locker number so the courier can put the parcel inside. The collection code is sent to the customer in a text message.

(a) Complete the table to identify **two** inputs, **two** processes and **two** outputs for this program. **[6]**

	1	2
Inputs		
Processes		
Outputs		

4 **Total: 5 marks**

A community theatre wants a program that lets people book seats for its shows online. A team of four programmers will write the program. The team uses decomposition before they start.

(a) Identify **three** sub-problems that the booking program could be broken down into. **[3]**

(b) Explain **one** way that decomposition helps the team of programmers. **[2]**

5 **Total: 2 marks**

Algorithmic thinking is used to plan the steps a drinks vending machine follows to sell one drink. The steps are shown below in the **wrong** order.

Step	Description
A	Release the chosen drink
B	The customer selects a drink
C	Check that enough money has been paid
D	Display the price of the chosen drink
E	The customer inserts money to pay the price shown

(a) Write the letters **A** to **E** in the boxes to show the correct order of the steps. The first box is the first step. **[2]**

1st	2nd	3rd	4th	5th

Total for this worksheet: 20 marks

MODULE K ALGORITHM DESIGN · K3

Structure diagrams

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.1.1, 2.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 4 marks

(a) Tick (✓) **one** box in each row to show whether each statement about structure diagrams is true or false. **[4]**

Statement	True	False
The box at the top of a structure diagram represents the whole problem.		
Each box can be broken down into smaller sub-problems shown on the level below it.		
A structure diagram uses a diamond-shaped box to show each decision.		
A structure diagram is used to record the value of each variable as an algorithm runs.		

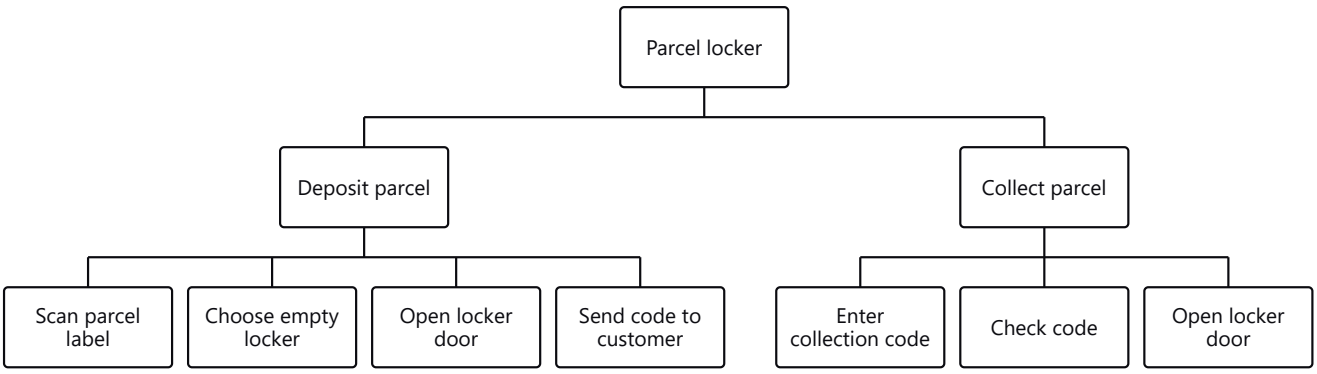
2

Total: 2 marks

(a) Describe what a structure diagram shows about a problem. **[2]**

3 **Total: 6 marks**

A delivery company is writing a program for its parcel lockers. A courier puts a parcel into an empty locker, and the customer is sent a code. Later, the customer types in the code to collect the parcel. The programmers have drawn this structure diagram.



(a) State the name of the subsection that **Check code** is part of. **[1]**

(b) Identify **one** input to the program that is shown on the structure diagram. **[1]**

(c) **Open locker door** appears in two different subsections. Explain how the programmers can make sure the code to open a locker door is only written once. **[2]**

(d) Three programmers will write the program. Explain **one** way that breaking the problem down like this helps the team. **[2]**

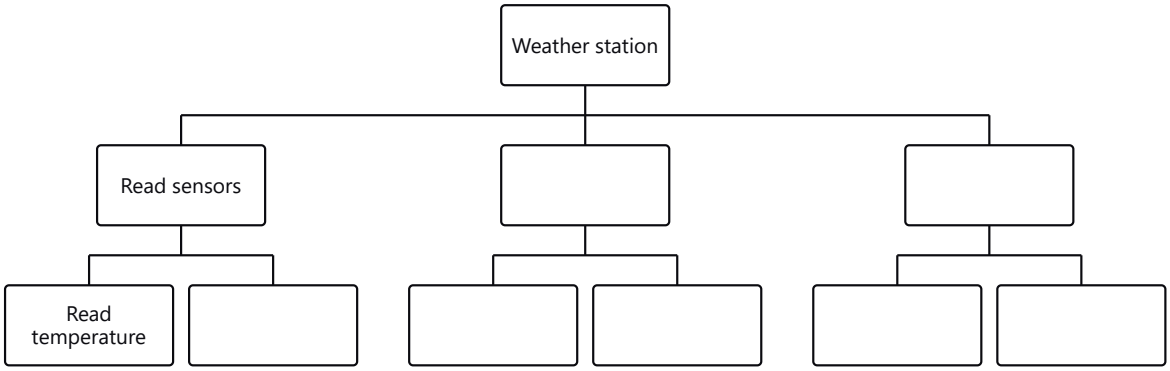
4

Total: 4 marks

A weather station program:

- reads two sensors: temperature and wind speed
- processes the readings: it calculates the average temperature for the day and finds the highest wind speed
- outputs the results: it displays them on a screen and saves them to a file.

(a) Complete the structure diagram for the weather station program. Write **one** sub-problem in each empty box. **[4]**



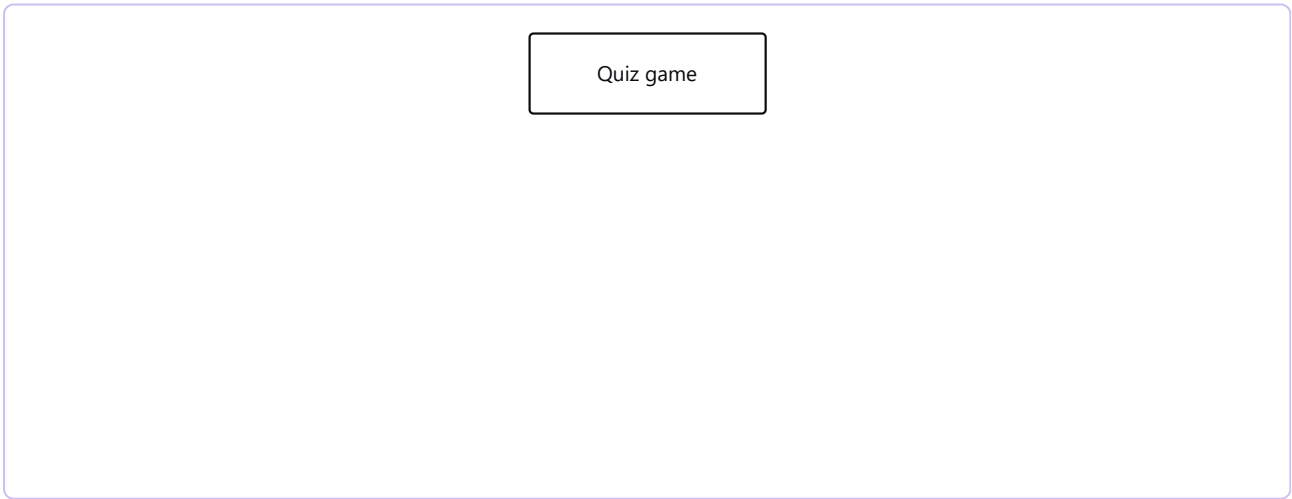
5

Total: 5 marks

A community centre wants a quiz program for its adult quiz nights. The program:

- sets up the game: the player enters their name and chooses a topic
- plays ten rounds: each round shows a question, gets the player's answer, then checks the answer and adds 1 to the score if it is correct
- ends the game: it displays the final score and saves it as a high score.

(a) Draw a structure diagram for the quiz program. The top box has been drawn for you. **[5]**



Total for this worksheet: 21 marks

MODULE K ALGORITHM DESIGN · K5

Reading and writing pseudocode

Original practice questions · 20 marks · ~25 minutes · OCR J277 spec 2.1.2, 2.3.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. All code in the questions is written in OCR Exam Reference Language. The total for this worksheet is **20 marks**.

1

Total: 1 mark

(a) Tick (✓) **one** box to show which statement describes pseudocode. **[1]**

Statement	✓
A diagram of symbols joined by lines that shows the steps of an algorithm	
A table used to record the values of variables as an algorithm is followed	
A structured, code-like way of writing an algorithm that is not tied to one programming language	
A programming language that must be translated by a compiler before it can run	

2

Total: 3 marks

Conditions in an algorithm must be written precisely. Rewrite each condition in OCR Exam Reference Language, using the variable name given.

(a) Complete the table. **[3]**

Condition written in English	Condition written in OCR Exam Reference Language
The value of `speed` is more than 70	
The value of `colour` is not the text red	
The value of `age` is from 18 to 65 inclusive	

3 **Total: 8 marks**

A café gives each customer a loyalty card. The customer gets one stamp for every cup of coffee they buy. When a card reaches 8 stamps, the customer earns a free drink and 8 stamps are taken off the card. The till uses this algorithm.

```
01 // Loyalty card stamps for the café
02 const TARGET = 8
03 stamps = int(input("Enter stamps already on card"))
04 cups = int(input("Enter cups bought today"))
05 stamps = stamps + cups
06 if stamps >= TARGET then
07     print("Free drink earned")
08     stamps = stamps - TARGET
09 else
10     print(str(TARGET - stamps) + " more needed")
11 endif
12 print("Stamps now: " + str(stamps))
```

(a) Identify the line number where:

(i) a constant is declared ..... **[1]**

(ii) the selection statement begins ..... **[1]**

(b) Complete the table to show the outputs from the algorithm for each set of inputs. **[4]**

stamps input	cups input	Outputs
5	2	
3	5	

(c) Identify **two** features of this code that make it easier to maintain. **[2]**

1

2

4 **Total: 4 marks**

A storeroom door has a keypad. The door should open if the correct access code is entered. The user should be allowed a maximum of **three** attempts. This algorithm has been written for the keypad, but it contains **two** logic errors.

```
01 const CODE = "K7Q2"
02 attempts = 0
03 unlocked = false
04 while unlocked == false AND attempts <= 3
05     entry = input("Enter access code")
06     if entry == CODE then
07         unlocked = true
08     endif
09     attempts = attempts - 1
10 endwhile
11 if unlocked == true then
12     print("Door open")
13 else
14     print("Access denied")
15 endif
```

(a) Identify the line number of each logic error and write the refined line of code to correct it. **[4]**

Line number	Refined line of code

5 **Total: 4 marks**

A garden centre has a sensor in its greenhouse. A worker types in temperature readings from the sensor.

(a) Write an algorithm that: **[4]**

- asks the user to enter **10** temperature readings, one at a time
- counts how many of the readings are more than 30
- outputs this count after all 10 readings have been entered.

You must use either OCR Exam Reference Language or a high-level programming language that you have studied.

Total for this worksheet: 20 marks

MODULE K ALGORITHM DESIGN · K6

Flowcharts: symbols and how to read them

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.1.2

Name _____ Date _____

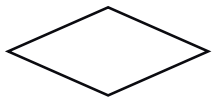
Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Draw flowcharts in pencil. The total for this worksheet is **21 marks**.

1

Total: 4 marks

The table shows four symbols that are used in flowcharts.

(a) Identify the name of each flowchart symbol A to D. Write each name in the table. **[4]**

	Symbol	Name of symbol
A		
B		
C		
D		

2

Total: 4 marks

A machine tests bouncing balls. A ball is dropped from a height, in cm, that is input. After each bounce the ball reaches half of its previous height. The machine counts the bounces until the height is less than 10 cm. The algorithm is shown in Fig. 1.

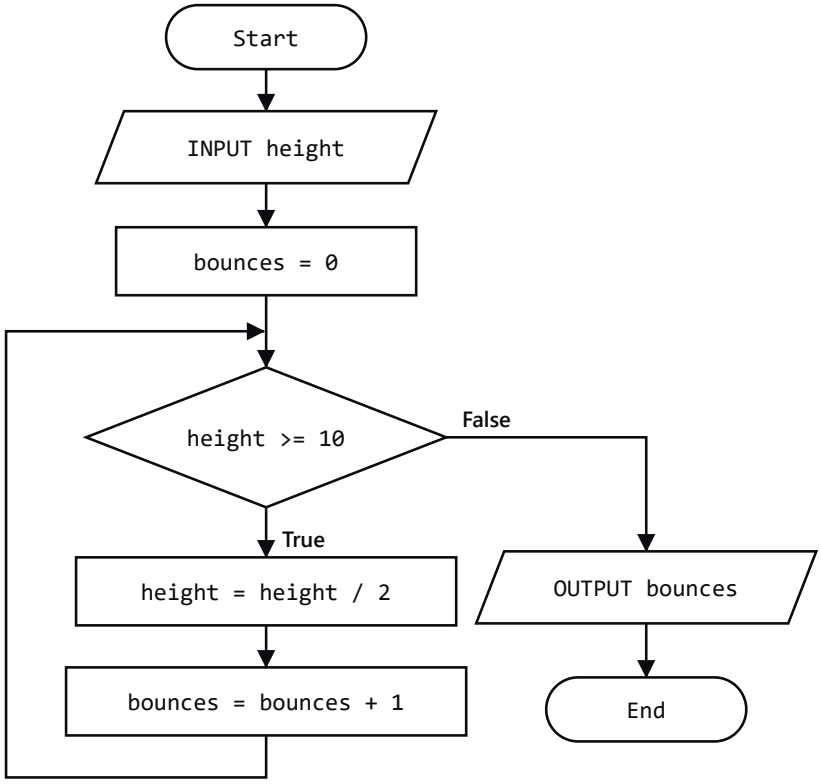


Fig. 1

(a) Complete the trace table for the flowchart in Fig. 1 when the input is `100`. You may not need to use all the rows. **[3]**

height	bounces	Output

(b) State the output of the flowchart in Fig. 1 when the input is `8`. **[1]**

3 **Total: 4 marks**

A swimming pool heater is controlled by an algorithm. The algorithm must:

- take the water temperature, in °C, as input
- set `heater` to `"On"` if the temperature is less than 27
- otherwise set `heater` to `"Off"`
- output the value of `heater`.

(a) The flowchart in Fig. 2 is incomplete. Complete the flowchart by writing the correct statement in each of the boxes **A**, **B**, **C** and **D**. **[4]**

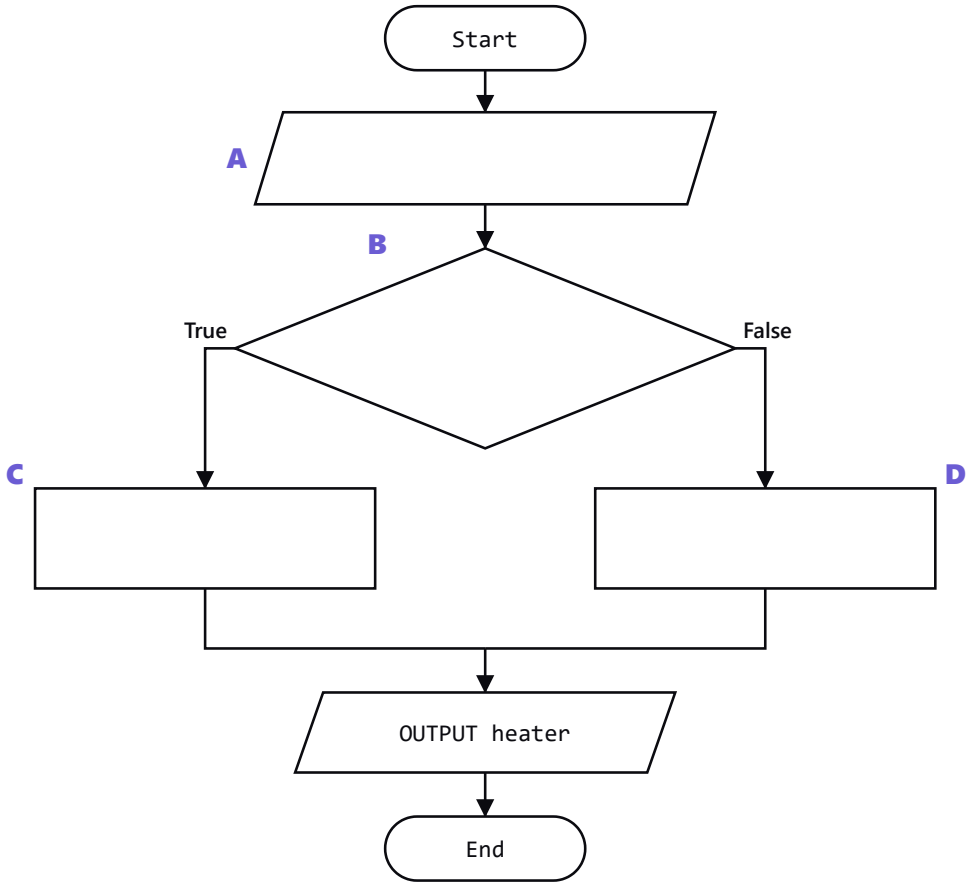


Fig. 2

4 **Total: 4 marks**

An electric scooter shows a message about its battery. The algorithm should:

- input the battery level as a whole-number percentage
- output `"Charge now"` if the battery level is 20 or less
- otherwise output `"Ready"`.

A programmer has drawn the flowchart in Fig. 3. The flowchart contains **two** errors.

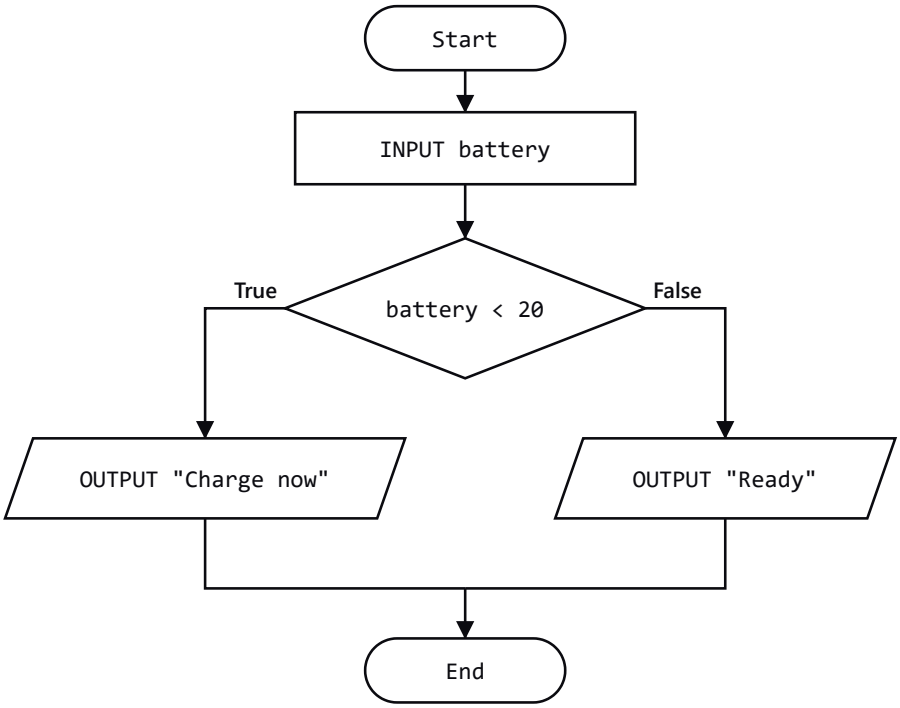


Fig. 3

(a) Identify the **two** errors in the flowchart in Fig. 3 and describe how to correct each one. **[4]**

Error 1	
Correction	
Error 2	
Correction	

5 **Total: 5 marks**

A climbing centre takes bookings for groups of climbers. An algorithm is needed that:

- inputs the number of climbers in a group
- checks that the number is between 1 and 8 inclusive; if it is not, outputs `"Invalid"` and asks for the number again
- calculates the cost at £15 per climber
- outputs the cost.

(a) Design the algorithm using a flowchart. **[5]**

Total for this worksheet: 21 marks

MODULE K ALGORITHM DESIGN · K7

Turning a problem into an algorithm

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 6 marks

A coworking office charges its members for printing. The first 30 pages a member prints each day are free. Every page after the first 30 costs 15p. A program is needed that takes the number of pages a member has printed today and works out the charge in pence.
For example, a member who prints 45 pages is charged 225 pence.

(a) Complete the table to identify **one** input, **one** process and **one** output for this program. **[3]**

	Description
Input	
Process	
Output	

(b) The problem is broken down into steps. Tick (✓) **one** box in each row to show whether each step needs sequence, selection or iteration. **[3]**

Step	**Sequence**	**Selection**	**Iteration**
Multiply the number of extra pages by 15			
Charge nothing if 30 pages or fewer were printed			
Keep asking for the number of pages until a number from 1 to 500 is entered			

2 **Total: 5 marks**

Write an algorithm for the printing charge in Question 1. The algorithm must:

- take as input the number of pages printed
- work out the charge in pence, using the rules in Question 1
- output the charge.

You may use pseudocode, a flowchart, OCR Exam Reference Language or a high-level programming language. **[5]**

3 **Total: 3 marks**

The printing algorithm is refined so that the number of pages entered must be from 1 to 500 (inclusive).

(a) Write an algorithm that takes the number of pages as input and keeps asking for it to be entered again until a number from 1 to 500 is entered. You may use pseudocode, a flowchart, OCR Exam Reference Language or a high-level programming language. **[3]**

4 **Total: 7 marks**

A ferry makes 8 crossings each day. At the end of each crossing, a member of the crew enters the number of passengers who were on board. A program is needed that:

- takes as input the number of passengers for each of the 8 crossings
- adds up the total number of passengers for the day
- counts how many crossings had **more than** 150 passengers
- outputs the total and the count after all 8 crossings have been entered.

(a) The program needs two variables. Complete the table to give a suitable identifier and the starting value for each variable. **[2]**

What the variable stores	Identifier	Starting value
The total number of passengers for the day		
The number of crossings with more than 150 passengers		

(b) Write the program described above. **[5]**
You must use either:
• OCR Exam Reference Language, or
• a high-level programming language that you have studied.

Total for this worksheet: 21 marks

MODULE K ALGORITHM DESIGN · K8

Trace tables and dry runs

Original practice questions · 21 marks · ~25 minutes · OCR J277 specification 2.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. All code is written in OCR Exam Reference Language. In each trace table, start a new row each time a value changes; you may not need to use all the rows. Leave the Output cell blank when nothing is output. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 2 marks

(a) State what a trace table is used for. **[1]**

(b) A programmer traces an algorithm. The algorithm runs to the end, but the trace table shows an output that is not what the programmer expected. **[1]**
State the type of error that the algorithm contains.

2

Total: 4 marks

A warehouse robot builds a stack of boxes. It keeps adding boxes until the stack is at least 100 cm tall. The height of each box, in cm, is entered.

```
01 height = 0
02 boxes = 0
03 while height < 100
04     boxSize = int(input("Enter box height"))
05     height = height + boxSize
06     boxes = boxes + 1
07 endwhile
08 print(boxes)
```

(a) Complete the trace table when the inputs are **30**, **45**, **20**, **15** and **40**, in that order. You may not need to use all the inputs. **[4]**

height	boxes	boxSize	Output
0	0		

3 **Total: 6 marks**

A weather station stores five daily temperatures, in °C, in the array `temps`. The array is indexed from 0.

```
01 array temps = [12, 17, 9, 21, 15]
02 highest = temps[0]
03 day = 0
04 for i = 1 to 4
05     if temps[i] > highest then
06         highest = temps[i]
07         day = i
08     endif
09 next i
10 print("Day " + str(day) + ": " + str(highest))
```

(a) Complete the trace table for this algorithm. The first row has been done for you. **[4]**

i	highest	day	Output
	12	0	

(b) Describe the purpose of this algorithm. **[2]**

4 **Total: 5 marks**

A pump engineer takes four pressure readings and needs the mean (average) of the four readings. This algorithm should output the mean, but it contains a logic error.

```
01 total = 0
02 for count = 1 to 4
03     reading = int(input("Enter reading"))
04     total = reading
05 next count
06 average = total / 4
07 print(average)
```

(a) Complete the trace table when the inputs are **8**, **6**, **10** and **4**, in that order. **[3]**

count	reading	total	average	Output
		0		

(b) Use your trace table to identify the line number that contains the logic error. Refine the line so that the algorithm outputs the mean of the four readings. **[2]**

5 **Total: 4 marks**

A print shop's cutting machine uses this algorithm. A whole number is entered. The algorithm keeps halving it, using integer division, until it reaches 1, and counts how many times it halves the number.

```
01 n = int(input("Enter width"))
02 steps = 0
03 do
04     n = n DIV 2
05     steps = steps + 1
06 until n == 1
07 print(steps)
```

(a) Create a trace table for this algorithm when the input is **13**. Write your own column headings in the top row. **[4]**

Total for this worksheet: 21 marks

MODULE K ALGORITHM DESIGN · K9

Finding and fixing errors in an algorithm

Original practice questions · 21 marks · ~25 minutes · OCR J277 specification 2.1.2 (with 2.3.2)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Where you write a corrected line of code, you may use OCR Exam Reference Language or a high-level programming language that you have studied. The total for this worksheet is **21 marks**.

1

Total: 3 marks

A programmer has written three lines of code. Each line contains **one** error.

(a) Tick (✓) **one** box in each row to show whether the error is a syntax error or a logic error. **[3]**

What the line should do	Line of code	Syntax error	Logic error
Output the message Goodbye	`print("Goodbye)`		
Repeat the code inside the loop 10 times	`for i = 1 to 9`		
Check whether the door code entered is 4821	`iff code == "4821" then`		

2

Total: 4 marks

A garden centre records six temperature readings (in °C) from its greenhouse each day and stores them in the array `temps`. The array is indexed from 0. The algorithm below should count how many of the readings are **30 or more** and output the count.

```
01 array temps = [28, 31, 30, 26, 33, 29]
02 hotCount = 0
03 for i = 1 to 6
04     if temps[i] > 30 then
05         hotCount = hotCount + 1
06     endif
07 next i
08 print("Hot readings: " + str(hotCount))
```

(a) The algorithm contains **two** logic errors. Identify the line number of each error and refine the code to correct it. **[4]**

Line number	Corrected line

3 **Total: 6 marks**

A charity auction takes four bids for a painting. The algorithm below should output the **highest** bid.

```
01 highest = 0
02 for bid = 1 to 4
03     amount = int(input("Enter bid amount"))
04     if amount < highest then
05         highest = amount
06     endif
07 next bid
08 print(highest)
```

(a) Complete the trace table for the algorithm when the bids entered are **25**, **40**, **15** and **30**, in that order. You may not need to use all the rows. **[3]**

bid	amount	highest	Output

(b) State the output the auction organisers expected for these four bids. **[1]**

(c) Identify the line number of the logic error and write the corrected line. **[2]**

4 **Total: 6 marks**

A courier depot weighs parcels before loading a van. The program below should ask for the weights of **five** parcels and then output their total weight.

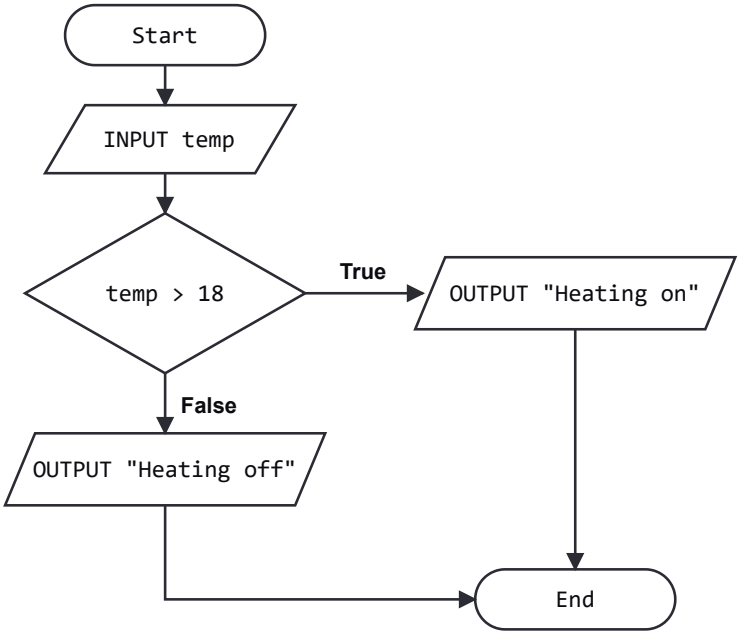
```
01 total = 0
02 count = 0
03 while count < 5
04     total = 0
05     weight = float(input("Enter parcel weight in kg"))
06     total = total + weight
07 endwhile
08 print("Total weight: " + str(total) + " kg")
```

(a) Describe what happens when this program is run. **[2]**

(b) The program contains **two** logic errors. For each error, explain what is wrong and how the code should be refined to correct it. Refer to line numbers in your answer. **[4]**

5 **Total: 2 marks**

A heating controller should switch the heating on when the room temperature is **below 18** °C, and off otherwise. A programmer has drawn this flowchart.



(a) State the output from the flowchart when the temperature input is **12**. **[1]**

(b) Describe how the flowchart should be corrected so that it works as intended. **[1]**

Total for this worksheet: 21 marks

MODULE K ALGORITHM DESIGN · K10

Explaining what an algorithm does

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.1.2, 2.1.3, 2.3.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. All code is written in OCR Exam Reference Language. The total for this worksheet is **21 marks**.

1

Total: 4 marks

A shop's program uses the four code fragments **A** to **D** below. Here are five descriptions:

1. Keeps the largest value seen so far
2. Adds one each time a value meets a condition
3. Keeps asking for a value until it is in an allowed range
4. Adds each value to a running total
5. Keeps the smallest value seen so far

(a) Write the number of the description (1 to 5) that matches each code fragment. Each description may be used once or not at all. **[4]**

Fragment	Code	Description number
A	`total = total + cost`	

B	`if cost > top then`
	`  top = cost`
	`endif`	

C	`while hours < 0 OR hours > 24`
	`  hours = int(input("Re-enter hours"))`
	`endwhile`	

D	`if cost < 5 then`
	`  cheap = cheap + 1`
	`endif`	

2 **Total: 5 marks**

A weather station records overnight temperatures in °C. A worker enters four temperatures into this algorithm.

```
01 z = int(input("Enter temperature"))
02 for y = 1 to 3
03     x = int(input("Enter temperature"))
04     if x < z then
05         z = x
06     endif
07 next y
08 print(z)
```

(a) Complete the trace table when the worker enters **3**, then **-1**, then **5**, then **-4**. You may not need to use all the rows. **[4]**

Line	x	y	z	Output

(b) State the purpose of the algorithm. **[1]**

3 **Total: 4 marks**

A delivery depot weighs parcels before they are loaded onto a van. This algorithm is used for each van.

```
01 heavy = 0
02 for parcel = 1 to 20
03     do
04         weight = float(input("Enter weight in kg"))
05     until weight > 0 AND weight <= 30
06     if weight > 25 then
07         heavy = heavy + 1
08     endif
09 next parcel
10 print("Heavy parcels: " + str(heavy))
```

(a) Describe what the algorithm does. Refer to the variables and values in the algorithm in your answer. **[4]**

4 **Total: 3 marks**

A café stores its menu prices in the array `prices`. This algorithm is run on the array.

```
01 do
02     swapped = false
03     for i = 0 to prices.length - 2
04         if prices[i] > prices[i + 1] then
05             temp = prices[i]
06             prices[i] = prices[i + 1]
07             prices[i + 1] = temp
08             swapped = true
09         endif
10     next i
11 until swapped == false
```

(a) Identify the standard algorithm shown. **[1]**

(b) State the purpose of the variable `swapped` in this algorithm. **[1]**

(c) State the order the prices are in after the algorithm has finished. **[1]**

5 **Total: 5 marks**

A river sensor stores water levels, in cm, in an array. When the sensor fails to take a reading, the value **-1** is stored instead.

```
01 function check(r)
02     t = 0
03     n = 0
04     for i = 0 to r.length - 1
05         if r[i] != -1 then
06             t = t + r[i]
07             n = n + 1
08         endif
09     next i
10     if n == 0 then
11         return 0
12     else
13         return t / n
14     endif
15 endfunction
```

(a) The array `levels` contains `[12, -1, 15, 9]`. State the value returned by `check(levels)`. **[1]**

(b) Explain the purpose of the function `check`. Refer to the variables in the function in your answer. **[3]**

(c) The name `check` does not describe what the function does. Suggest a more meaningful name for the function. **[1]**

Total for this worksheet: 21 marks