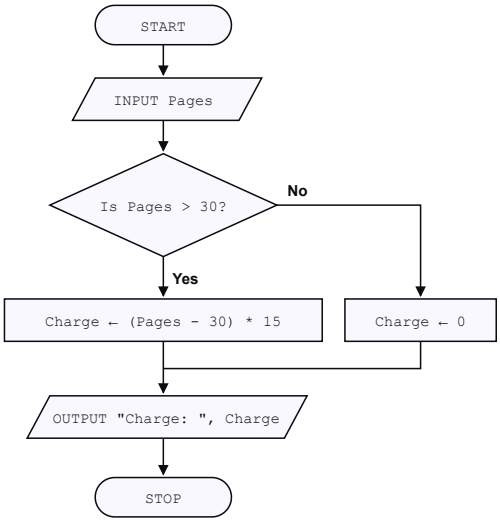
MODULE K ALGORITHM DESIGN · K7

Turning a problem into an algorithm: mark scheme

22 marks · Cambridge 0478 syllabus 7.2(b) (decompose a problem: inputs, processes, outputs, storage), 7.2(c) (design methods: flowcharts, pseudocode), 7.9 (write and amend algorithms using pseudocode and flowcharts), 8.1 (variables; sequence, selection, iteration; totalling and counting)

How to use. One mark per bullet point up to the maximum shown. **/** separates alternative words; **//** separates alternative answers. Words in (brackets) are not needed for the mark. Algorithms must be precise: `Pages > 30` is acceptable, "pages is more than thirty" is not. Questions 3 and 4(b) must be answered in pseudocode; program code scores 0. Ignore minor syntax slips. Example answers are one possible response, not the only one.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) 0478 7.2(b)	**Input:** the number of pages printed (today) **Process:** any one from: check whether more than 30 pages were printed // subtract 30 from the number of pages // multiply the extra pages by 15 // calculate the charge **Output:** the charge (in cents) **Storage:** any one from: the number of pages // the charge // the number of free pages (30) // the cost per page (15 cents)	**4**	One mark per row. Credit any other valid process or stored item. Do not accept "the charge" as the input, or "the number of pages" as the output. Do not accept "printing" as the process, or "the printer" / "a database" alone as storage.
1(b) 0478 8.1.4(a)–(c)	Multiply the extra pages by 15: **Sequence** Charge nothing if 30 pages or fewer: **Selection** Keep asking until 1 to 500 is entered: **Iteration**	**3**	One mark per correct row. A row with more than one tick scores 0.

QUESTION	ANSWER	MARKS	GUIDANCE
2 0478 7.9, 7.2(c)	One mark per bullet point. Max 5. START and STOP terminators Input of the number of pages in an input/output symbol Decision symbol checking more than 30 pages (e.g. `Is Pages > 30?`) with both exits labelled Yes/No (True/False) the right way round Charge calculated as (Pages − 30) * 15 on the "more than 30" route Charge set to 0 on the "30 or fewer" route // charge set to 0 before the decision Output of the charge in an input/output symbol Flow lines with arrows joining every symbol, with both routes reaching the output and STOP Example answer:  	**5**	Max 5. Accept `Pages * 15 - 450` for the calculation. Accept a decision such as `Is Pages <= 30?` with the Yes/No routes the other way round. Accept `Is Pages >= 30?` (or `Is Pages < 30?` with the Yes/No routes swapped), because at exactly 30 pages (30 − 30) * 15 = 0, so the charge is still correct. Do not award the decision mark if the exits are not labelled. Non-standard symbols (e.g. a rectangle for an input): do not award that symbol's mark. Do not accept a decision written in vague English ("Is it over the limit?").

QUESTION	ANSWER	MARKS	GUIDANCE

3(a)
0478 7.9
	One mark per bullet point. Max 3.
	Input of the number of pages
	A condition-controlled loop (REPEAT … UNTIL or WHILE … DO … ENDWHILE) with the correct closing keyword
	… with a correct condition that checks both limits (e.g. `UNTIL Pages >= 1 AND Pages <= 500` // `WHILE Pages < 1 OR Pages > 500 DO`)
	The number of pages is input again inside the loop
	Example answers:
	`REPEAT`
	`  OUTPUT "Enter the number of pages (1 to 500)"`
	`  INPUT Pages`
	`UNTIL Pages >= 1 AND Pages <= 500`
	//
	`INPUT Pages`
	`WHILE Pages < 1 OR Pages > 500 DO`
	`  OUTPUT "Invalid, enter a number from 1 to 500"`
	`  INPUT Pages`
	`ENDWHILE`
		3	Max 3. An IF statement with no loop (checks only once): max 1. Do not credit a condition with a missing variable (e.g. `Pages < 1 OR > 500`) or AND / OR the wrong way round. Accept `Pages <= 0 OR Pages >= 501`. Do not accept "between 1 and 500" in English.

4(a) 0478 8.1.1	Total: a meaningful identifier, e.g. `TotalPassengers` // `Total`, **and** initial value 0 Count: a meaningful identifier, e.g. `BusyCrossings` // `Count`, **and** initial value 0	**2**	One mark per row; both the identifier and the initial value are needed. Do not accept identifiers containing spaces, single letters, or keywords (e.g. `INPUT`, `OUTPUT`). Do not penalise the use of lower case or underscores.

QUESTION	ANSWER	MARKS	GUIDANCE

4(b)
0478 7.9, 8.1.4(c)(d)
	One mark per bullet point. Max 5.
	A loop that repeats 8 times, with the correct closing keyword (e.g. `FOR Crossing ← 1 TO 8` … `NEXT Crossing`)
	Input of the number of passengers inside the loop
	Totalling inside the loop (e.g. `Total ← Total + Passengers`)
	IF statement checking `Passengers > 150`, with ENDIF … counting only when the condition is true (e.g. `Count ← Count + 1`)
	Total **and** count both output after the loop, with suitable messages
	Example answer:
	`TotalPassengers ← 0`
	`BusyCrossings ← 0`
	`FOR Crossing ← 1 TO 8`
	`  OUTPUT "Enter the number of passengers on this crossing"`
	`  INPUT Passengers`
	`  TotalPassengers ← TotalPassengers + Passengers`
	`  IF Passengers > 150`
	`  THEN`
	`  BusyCrossings ← BusyCrossings + 1`
	`  ENDIF`
	`NEXT Crossing`
	`OUTPUT "Total passengers today: ", TotalPassengers`
	`OUTPUT "Crossings with more than 150 passengers: ", BusyCrossings`
		5	Max 5. Pseudocode only; program code scores 0. Accept a REPEAT or WHILE loop with a counter that correctly runs 8 times. Accept `>= 151`; do not accept `>= 150`. Accept = or <- for assignment. Do not award the totalling / counting mark if the total or count is reset to 0 inside the loop. Outputs inside the loop do not gain the output mark.

Total: 22 marks