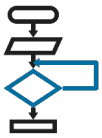
N5 Engineering Science
Programmable Control
Past paper questions and marking instructions



Contents

Question	What it covers	Marks	Answers
2014 Question 7	Microcontroller advantages	2	Answers
2014 Question 13	Flowchart: ski chair lift	10	Answers
2015 Question 5	Microcontroller advantages	2	Answers
2015 Question 15 (a) and (b)	Flowchart: speed sign; loop type	7	Answers
2016 Question 2	Microcontroller advantages	2	Answers
2016 Question 12 (c)	Flowchart: dinosaur model	8	Answers
2017 Question 9	Flowchart: game show display	9	Answers
2018 Question 10 (a)	Flowchart: tennis ball machine	10	Answers
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2019 Question 15	Flowchart: hair straighteners; wiring	11	Answers
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2023 Question 8 (a)	Flowchart: seatbelt warning	10	Answers
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2024 Question 11 (b)	Flowchart: dishwasher drying cycle	11	Answers
2025 Question 2	Reading a program; fixed loop	3	Answers
2025 Question 8 (c)	Microcontroller advantage	2	Answers
2025 Question 9	Flowchart: ski start; wiring; transistor	13	Answers
2026 Question 12 (a)	Flowchart: electric toothbrush	10	Answers
2026 Question 13 (e)	Microcontroller advantages	2	Answers

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Question	What it covers	Marks	Answers
Specimen Question 13 (a)	Flowchart: laser cutter	7	Answers
Specimen Question 14 (d)	Microcontroller advantage	2	Answers

Sources and credits

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2014 Question 7

N5 Engineering Science 2014 paper, Section 1, Question 7. Total: 2 marks

MARKS | DO NOT WRITE IN THIS MARGIN

7. Microcontrollers are used in many control systems.

State two reasons why microcontroller based systems are often less expensive to manufacture than hard-wired circuits. 2

1 _____

_____

2 _____

_____

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2014 Question 7: marking instructions

Question			Expected Answer(s)	Max Mark	Additional Guidance
7.			Fewer parts Reduced materials Reduced stock one IC (standard component) used in multiple products Quicker manufacture time	2	1 mark for each economic based valid answer Not easy to repair or cheaper Not smaller/reprogrammable (flexible) without economic reason

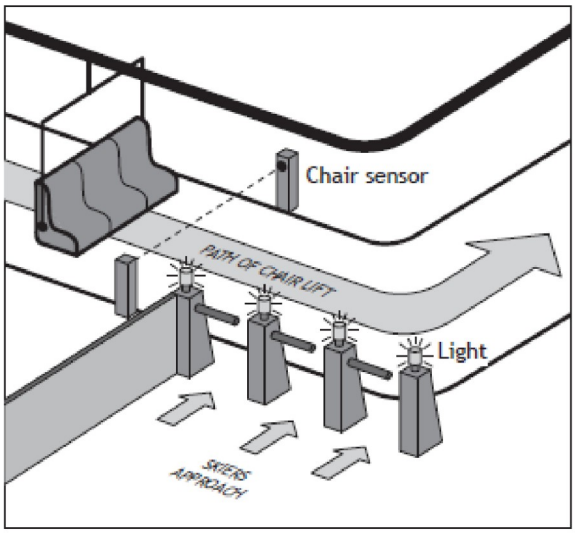
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2014 Question 13

N5 Engineering Science 2014 paper, Section 2, Question 13. Total: 10 marks

MARKS | DO NOT WRITE IN THIS MARGIN

13. A chair lift system at a ski resort is operated by a microcontroller.



The system must perform the following sequence.

- When the chair sensor is triggered warning lights flash 4 times over a 2 second period.
- The barriers will then open.
- The system will pause for 3 seconds to allow the skiers through.
- The barriers will then close.
- The sequence will repeat.

Input and output connections to the microcontroller are shown in the table below.

Input Connection	Pin	Output Connection
	2	Barriers (1 = open)
	1	Warning lights
Chair sensor (1 = chair sensed)	0	

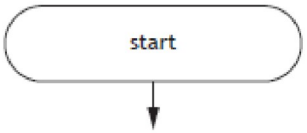
Complete the flowchart opposite for the control sequence with reference to the Data Booklet and input/output connections. 10

Include all pin numbers.

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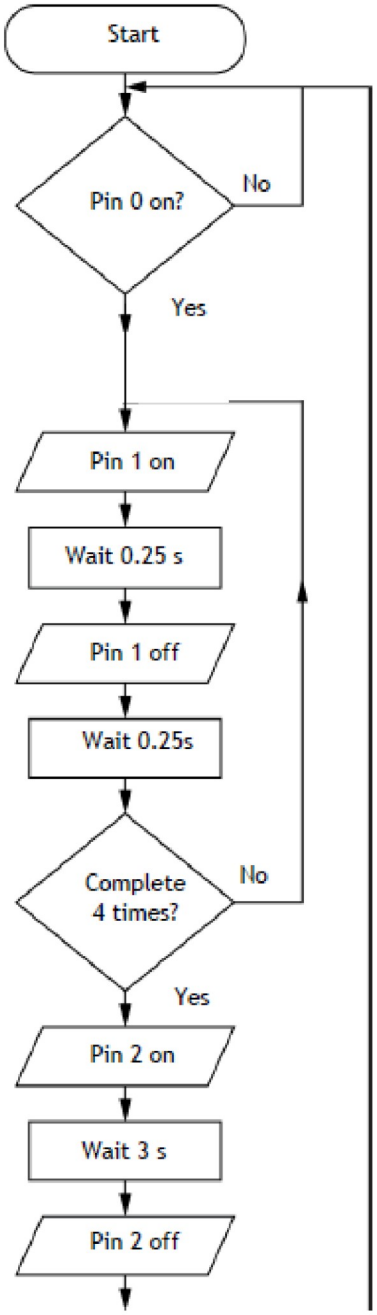
13. (continued)

MARKS | DO NOT WRITE IN THIS MARGIN



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2014 Question 13: marking instructions

Question	Expected Answer(s)	Max Mark	Additional Guidance
13.		10	Pin number must be correct where applicable Pin 0 on? - 1 mark for decision with y/n and loop Pin1 on/off - 1 mark for both boxes Wait - 1 mark for both - 1 mark both times totalling 0.5 s x 4 decision with y/n - 1 mark decision loop return point - 1 mark Pin2 on/off - 1 mark for both Wait 3s - 1 Continuous loop - 1 All marked symbols correct - 1 (additional boxes ignored) Credit given for a series of flashes done without fixed loop. (1 mark)

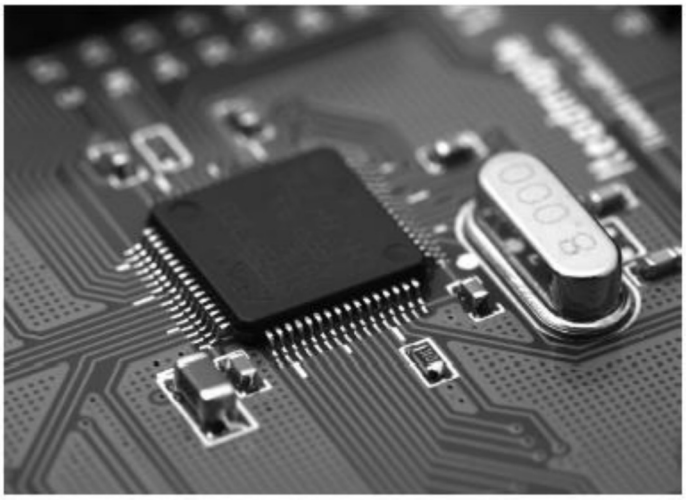
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2015 Question 5

N5 Engineering Science 2015 paper, Section 1, Question 5. Total: 2 marks

MARKS | DO NOT WRITE IN THIS MARGIN

5. Microcontrollers are often used in place of hard wired electronic circuits in control systems.



Describe an advantage of a microcontroller over a hard wired circuit for:

(a) a design engineer; 1

_____

_____

(b) a manufacturer during the production of the control system. 1

_____

_____

[Turn over

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2015 Question 5: marking instructions

Question			Expected Answer(s)	Max Mark	Additional Guidance
5.	(a)		Easier / quicker / simpler to develop than design a complex electronic circuit. Easier/quicker to update/modify.	1	Easier / quicker / simpler must be qualified. Descriptive responses only. Not smaller.
	(b)		The circuits will be manufactured more quickly and more cheaply due to fewer components/ easier to wire. One controller could be used in a number of products.	1	Smaller/cheaper/reliable/quickly must be qualified. Other suitable descriptive responses with qualifying statements accepted.

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2015 Question 15 (a) and (b)

N5 Engineering Science 2015 paper, Section 2, Question 15 (a) and (b). Total: 7 marks

15. A sign used to display a car's speed is shown below.



The sign is operated by a microcontroller. Input and output connections to the microcontroller are shown in the table below.

Input connections	Pin	Output connections
	7	
	6	speed display
	5	"smiley" face display
	4	
	3	
speed sensor (1 = too fast)	2	
	1	
	0	

The sign operates using the following sequence.

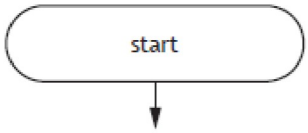
1 The speed sensor measures the speed of the car.
2 If the car is moving too fast, the speed display sign is switched on for 0·5 seconds.
3 If the car is not moving too fast, the "smiley" face display is switched on for 1 second.
4 The sequence then repeats.

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MARKS | DO NOT WRITE IN THIS MARGIN

15. (continued)

(a) Complete the flowchart for the sequence with reference to the Data Booklet and input/output connections. Include all pin numbers in your flowchart. 6



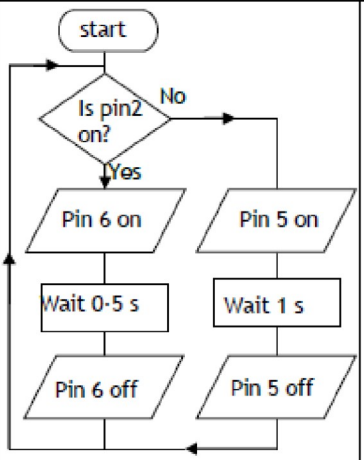
(b) State the type of program loop used in the operation of the sign. 1

_____

[Turn over

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2015 Question 15 (a) and (b): marking instructions

Question			Expected Answer(s)	Max Mark	Additional Guidance
15.	(a)		 1 mark for decision -(pin) 2, with Y or N labelled 1 mark for both (pin) 6 on/off 1 mark for both (pin) 5 on/off 1 mark both pauses 1 mark for continuous loop with arrow 1 mark for all symbols correct	6	Allow FTE for incorrect pin being switched on. Ignore any additional steps *Pause 1000* (PBASIC) or *Delay 1000* (C) accepted as wait 1s etc
	(b)		Continuous / infinite loop	1	Named or Described

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2016 Question 2

N5 Engineering Science 2016 paper, Section 1, Question 2. Total: 2 marks

2. Describe two advantages of a microcontroller based control system compared to a hard-wired electronic circuit. 2

2016 Question 2: marking instructions

Question			Expected Answer(s)	Max Mark	Additional Guidance
2.			Fewer parts Increased reliability Simplified/faster assembly Can be reprogrammed Re-usable Upgradable - system's features can be quickly/easily changed Reduced stock inventory (one microcontroller circuit can be repurposed)	2	1 mark per each correct descriptive response. Accept - easier to fix mistakes Not smaller or cheaper on its own. Not programmable

2016 Question 12 (c)

N5 Engineering Science 2016 paper, Section 2, Question 12 (c). Total: 8 marks

MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

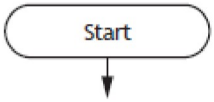
A microcontroller is used to operate the model in the sequence shown below.

1 When a start switch is activated the arms will move.
2 After 1·5 seconds the dinosaur will then roar for 1 second.
3 After another 0·5 seconds the arms should halt.
4 Steps 2 and 3 will repeat three times.
5 The sequence will then repeat.

Input/output connections to the microcontroller are shown in the table below.

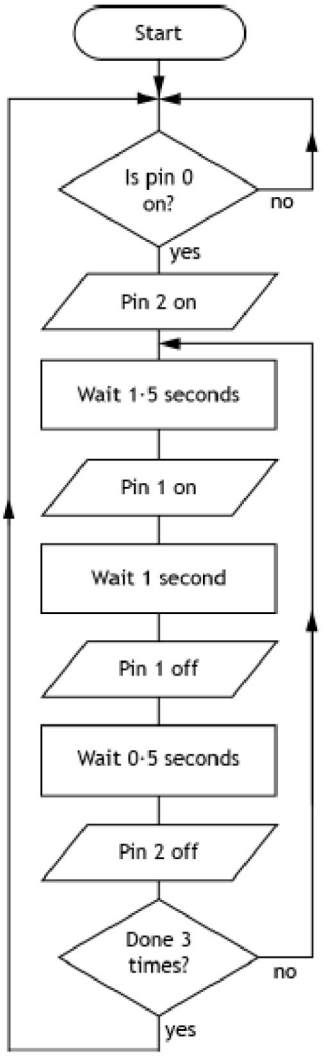
Input Connection	Pin	Output Connection
	2	arms
	1	roar
start switch	0	

(c) Complete the flowchart for the control sequence with reference to the Data Booklet and input/output connections. Include all pin numbers. 8



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2016 Question 12 (c): marking instructions

Question	Expected Answer(s)	Max Mark	Additional Guidance
(c)		8	All pin numbers must be correct where applicable. • (pin) 0 on decision, feedback loop with yes/no and arrow. 1 mark • (pin) 2 on and off. 1 mark • all three delays 1 mark Accept PBASIC/C alternatives (pause 1500 / delay 1500) • (pin) 1 on and off. 1 mark • x3 times decision with yes / no labelled. 1 mark • fixed loop with arrow to return point. 1 mark • Continuous loop with arrow. 1 mark • All symbols correct. 1 mark Credit given for a series of roar/ arm movement without a fixed loop. Ignore any additional steps including symbols used.

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2017 Question 9

N5 Engineering Science 2017 paper, Section 2, Question 9. Total: 9 marks

9. A question display board in a television game show is operated by a microcontroller. Contestants are shown a question and given 10 seconds to answer.

The system must perform the following sequence:

- When the host presses a question switch, a display turns on showing the question.
- When the host presses a timer start switch, an LED will pulse on and off 16 times over an 8 second period.
- A buzzer will then sound for 2 seconds.
- The buzzer and display board then turn off.
- The system then restarts ready for the next question.

Input and output connections to the microcontroller are shown in the table below.

Input Connection	Pin	Output Connection
	7	Display board
	6	LED
	5	Buzzer
Timer start switch	1	
Question switch	0	

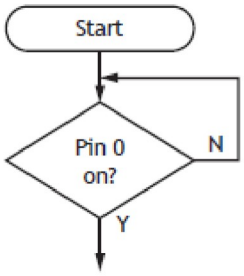
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MARKS | DO NOT WRITE IN THIS MARGIN

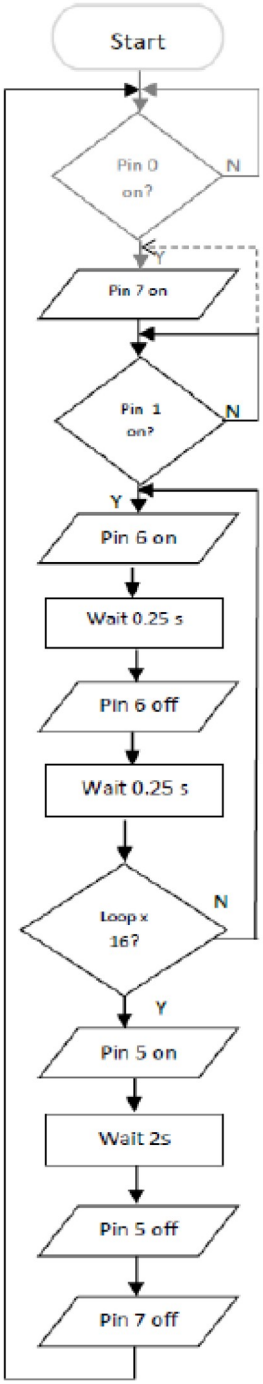
9. (continued)

Complete, with reference to the Data Booklet and the input and output connections shown, the flowchart for the control sequence. Include all pin numbers in your flowchart. 9



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2017 Question 9: marking instructions

Question	Expected answer(s)	Max mark	Additional guidance
9.		9	Pin numbers must be correct where applicable. Pin 7 on and off - 1 Pin 6 on and off - 1 Pin 5 on and off - 1 Pin 1 on? (inc. Y/N, loop and arrow head) - 1 All 3 delays (with wait 2s) - 1 Assume all delays in seconds unless units are given or a high level command is used: pause 250 (PBASIC) delay 250 (C) LED on/off time total = 0.5 s - 1 Loop x 16? (inc. Y/N, loop and arrow to before pin 6 on) - 1 Continuous loop (with arrow to start) - 1 All marked symbols correct - 1 Ignore any additional steps.

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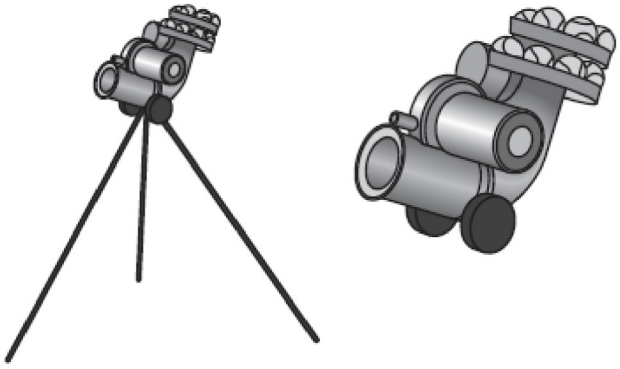
2018 Question 10 (a)

N5 Engineering Science 2018 paper, Section 2, Question 10 (a). Total: 10 marks

SECTION 2 — 90 marks
Attempt ALL questions

DO NOT WRITE IN THIS MARGIN

10. A ball firing machine used by tennis players to practise is shown below.



The machine is operated by a microcontroller. Input and output connections to the microcontroller are shown in the table below.

Input connections	Pin	Output connections
	7	ball firing motor
	6	red light
	5	green light
	4	ball release
start button	0	

The machine operates using the following sequence.

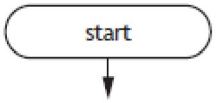
1. When the start button is pressed the ball firing motor starts and the red light switches on.
2. There is a 5 second delay after which the red light switches off and the green light switches on.
3. The ball release is then switched on for 0·5 seconds.
4. The ball release is then switched off for 2 seconds.
5. Steps 3 and 4 are then repeated ten times.
6. The ball firing motor and green LED then switch off and the system resets ready to be used again.

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MARKS | DO NOT WRITE IN THIS MARGIN

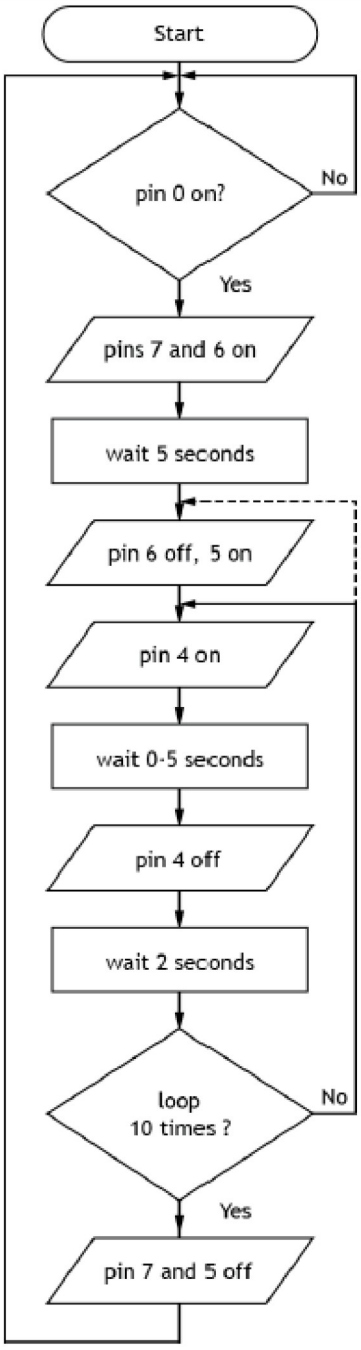
10. (continued)

(a) Complete the flowchart for the sequence, with reference to the Data Booklet and input/output connections. Include all pin numbers and delay units in your flowchart. 10



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2018 Question 10 (a): marking instructions

Question	Expected response	Max mark	Additional guidance
10. (a)		10	Pin numbers must be correct where applicable Pin 0 on ? (inc Y or N, loop and arrow head) - 1 mark Pin 7 on and off positions - 1 mark Pin 6 on and off positions - 1 mark Pin 5 on and off positions - 1 mark Pin 4 on and off positions - 1 mark All three delays with unit - 1 mark Loop x10 ? decision (inc Y or N) - 1 mark Feedback loop and arrow to before pin 4 on - 1 mark Continuous loop (with arrow to start) - 1 mark All marked symbols correct - 1 mark Ignore any additional steps.

2018 Question 12 (b)

N5 Engineering Science 2018 paper, Section 2, Question 12 (b). Total: 3 marks

(b) An electronic engineer decides to use a microcontroller based system to operate the lock rather than a logic circuit.

(i) Describe a functional advantage of using a microcontroller based system rather than a logic circuit to operate the lock. 1

(ii) Explain why using a microcontroller based system, rather than a logic circuit, is better for the environment. 2

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2018 Question 12 (b): marking instructions

Question			Expected response	Max mark	Additional guidance
	(b)	(i)	A variety of unlock codes can be programmed User can set own unlock code Time delays can be incorporated Automatic lockout after a set number of incorrect attempts	1	1 mark for any description of an advantage relating to function Response must relate to the context (lock control/coding)
		(ii)	Less components needed to be manufactured so less fumes produced. Less materials needed so fewer natural resources used up Can be reprogrammed/reusable therefore less waste (to landfill).	2	Response must relate to environment 1 mark for cause (advantage) 1 mark for effect (reason for advantage) Do not accept less materials used as an effect on its own. Do not accept less waste material

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2019 Question 10 (d)

N5 Engineering Science 2019 paper, Section 2, Question 10 (d). Total: 1 marks

(d) Describe an advantage of using a microcontroller to control the movement of the piston. 1

[Turn over

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2019 Question 10 (d): marking instructions

Question			Expected response	Max mark	Additional guidance
	(d)		The control of the piston movement could be easily changed/updated. The piston time delay could be easily changed/shortened. The piston time delay could be more consistent/accurate.	1	Descriptive response relating to advantage of microcontroller control of piston movement. Do not accept fewer components or cost savings.

2019 Question 15

N5 Engineering Science 2019 paper, Section 2, Question 15. Total: 11 marks

MARKS | DO NOT WRITE IN THIS MARGIN

15. A set of hair straighteners is shown.



A microcontroller is used to operate the hair straighteners using the following simplified sequence.

- When a push switch is operated the heating plates turn on.
- A buzzer will then sound for 0·8 seconds and then turn off.
- An LED will then repeatedly turn on for 0·3 seconds and turn off for 0·3 seconds until the correct temperature is reached.
- When the push switch is pressed again the heating plates turn off.
- The sequence will then repeat.

Input and output connections to the microcontroller are shown in the table below.

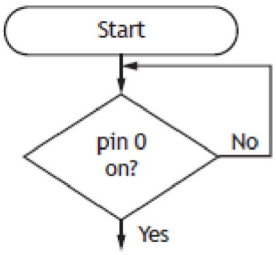
Input connection	Pin	Output connection
	7	Heating plates
	6	Buzzer
	5	LED
Temperature sensor (1 = correct temperature)	1	
Push switch	0	

(a) Complete the flowchart shown opposite for this simplified sequence, with reference to the data booklet and input/output connections.

Include all pin numbers and delay units in your flowchart. 9

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15. (a) (continued)



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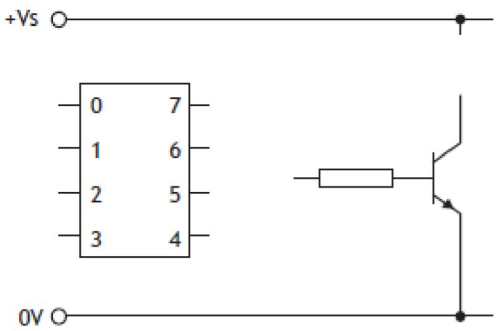
[Turn over for next question

MARKS | DO NOT WRITE IN THIS MARGIN

15. (continued)

The buzzer is switched on by a transistor connected to pin 6 of the microcontroller.

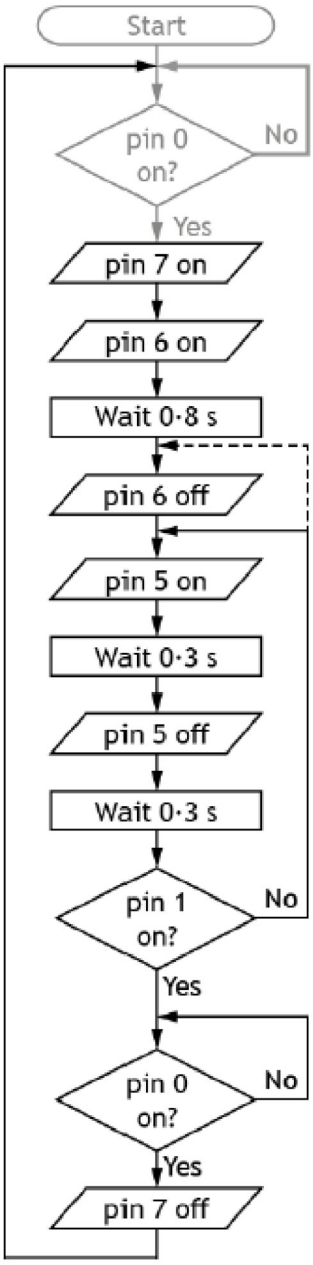
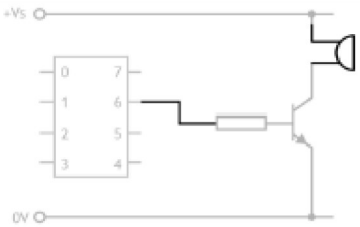
(b) Complete the diagram below by adding the symbol for a buzzer and the connection to the microcontroller. 2



[END OF QUESTION PAPER]

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2019 Question 15: marking instructions

Question			Expected response	Max mark	Additional guidance
15.	(a)			9	Pin numbers must be correct where applicable. Pin 7 on and off positions - 1 mark. Pin 6 on and off positions - 1 mark. All three delays positions (0·8 s and 2 x 0·3 s) with unit - 1 mark. Pin 5 on and off in positions - 1 mark. Pin 1 on ? with Y/N - 1 mark. Loop and arrow (Pin 1 on ?) back to before Pin 5 on - 1 mark. Pin 0 on ? with Y/N loop and arrow - 1 mark. Continuous loop to start with arrow - 1 mark. All marked symbols correct - 1 mark. Ignore any additional steps.
	(b)			2	1 mark pin 6 connection. 1 mark for buzzer symbol and connection.

[END OF MARKING INSTRUCTIONS]

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2021 Question 7

N5 Engineering Science 2021 paper, Section 1, Question 7. Total: 4 marks

MARKS | DO NOT WRITE IN THIS MARGIN

7. Microcontroller based systems are often used to create open loop and closed loop control.

(a) Describe the **difference** between open loop control and closed loop control. **2**

(b) Describe two advantages of a microcontroller based system compared to a hard wired electronic circuit. **2**

Advantage 1 _____

Advantage 2 _____

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2021 Question 7: marking instructions

Question			Expected response	Max mark	Additional guidance
7.	(a)		Open loop does not have feedback where closed loop has feedback.	**2**	Must be descriptive response. 1 mark for no feedback. 1 mark for has feedback. Do not accept has a sensor on its own.
	(b)		Fewer parts. Increased reliability. Simplified/faster assembly. Can be reprogrammed. Re-usable. Upgradable – system's features can be quickly/easily changed. Reduced stock inventory (one microcontroller circuit can be repurposed).	**2**	1 mark per each correct descriptive response. Accept – easier to fix mistakes. Not smaller or cheaper on its own. Not programmable.

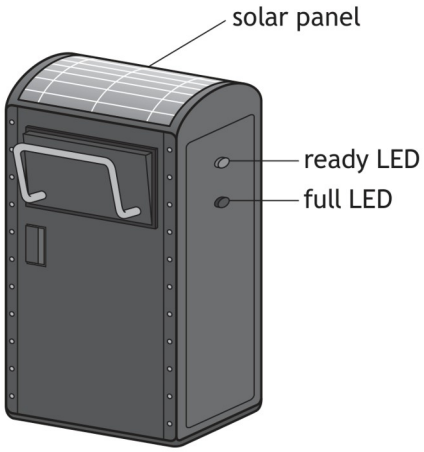
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2021 Question 13 (b)

N5 Engineering Science 2021 paper, Section 2, Question 13 (b). Total: 11 marks

MARKS | DO NOT WRITE IN THIS MARGIN

13. A solar powered rubbish compactor which crushes waste to increase its storage capacity is shown.



rubbish compactor

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MARKS | DO NOT WRITE IN THIS MARGIN

13. (continued)

A microcontroller is used to operate the rubbish compactor using the following sequence. The sequence runs after the rubbish compactor has been emptied and reset.

- A full LED will switch off and a ready LED will switch on
- When a rubbish level sensor is activated, a crusher will start to move down
- The crusher will stop when a force sensor is activated
- After a delay of 0·5 seconds the crusher will move up until a limit switch is activated
- If the rubbish level sensor is off, the sequence will return to the start
- If the rubbish level sensor is still activated the ready LED will switch off and the full LED will switch on
- The sequence will end

Input and output connections to the microcontroller are shown in the table below.

Input connection	Pin	Output connection
	7	crusher up
	6	crusher down
	5	full LED
	4	ready LED
force sensor	2	
limit switch	1	
rubbish level sensor	0	

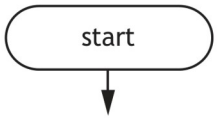
(b) Complete the flowchart opposite for this sequence, with reference to the data booklet and input/output connections.

Include **all** pin numbers and the delay unit in your flowchart. **11**

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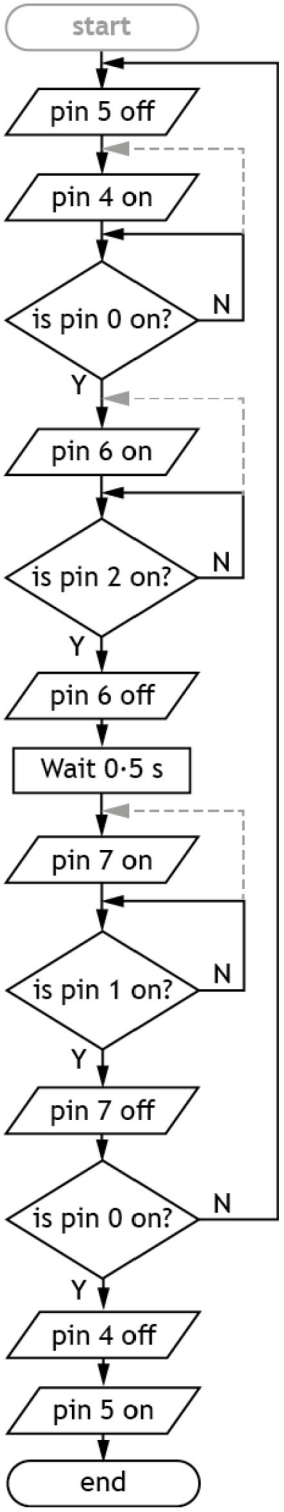
DO NOT WRITE IN THIS MARGIN

13. (b) (continued)



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2021 Question 13 (b): marking instructions

Question	Expected response	Max mark	Additional guidance
(b)		11	Pin numbers must be correct where applicable. Pin 5 off and on positions. **(1 mark)** Pin 4 on and off positions. **(1 mark)** Pin 6 on and off positions. **(1 mark)** Pin 7 on and off positions. **(1 mark)** 0·5 s delay. **(1 mark)** Pin 0 on ? with Y/N, loop and arrow. **(1 mark)** Pin 3 on ? with Y/N, loop and arrow. **(1 mark)** Pin 2 on ? with Y/N, loop and arrow. **(1 mark)** Pin 0 on ? (second) with Y/N, loop and arrow. **(1 mark)** End. **(1 mark)** All marked symbols correct. **(1 mark)** Ignore any additional steps.

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2022 Question 9

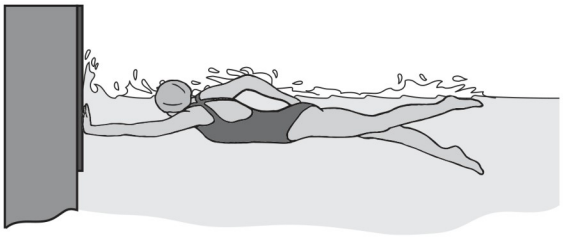
N5 Engineering Science 2022 paper, Section 2, Question 9. Total: 13 marks

DO NOT WRITE IN THIS MARGIN

SECTION 2 — 90 marks

Attempt ALL questions

9. In a swimming competition, a system is used to automatically measure a competitor's time.



The system is operated by a microcontroller.

The input and output connections to the microcontroller are shown in the table below.

Input connections	Pin	Output connections
	7	buzzer
	6	timer
lane switch	1	
master switch	0	

The system operates using the following sequence.

- A master switch is pressed
- A buzzer then sounds on and then off three times over 1.5 seconds
- The timer then starts
- When a lane switch is pressed the timer stops
- The system will then reset ready to be used again

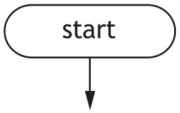
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MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(a) Complete the flowchart for the sequence, with reference to the data booklet and input/output connections.

Include **all** pin numbers and delay units in your flowchart. **10**



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MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

A program used in a different control system is listed below.

```
line    program
1       main:     let count = 0
2       label_1:     switch on 4
3                    switch on 5
4                    pause 600
5                    switch off 4
6                    switch off 5
7                    pause 600
8                    let count = count + 1
9                 if count = 20 then label_2
10                goto main
11      label_2:  if Input0 is on then label_3
12                goto label_2
13      label_3:  switch on 7
14                pause 3000
15                switch off 7
16                goto main
```

(b) Describe the function of **line 16** in the program. **1**

_____

_____

Lines 2 to **9** should repeat twenty times before moving on to **line 11**.

During testing an electronic engineer found that this did not happen.

(c) Explain why **lines 2** to **9** did not repeat twenty times before moving on to **line 11**. **2**

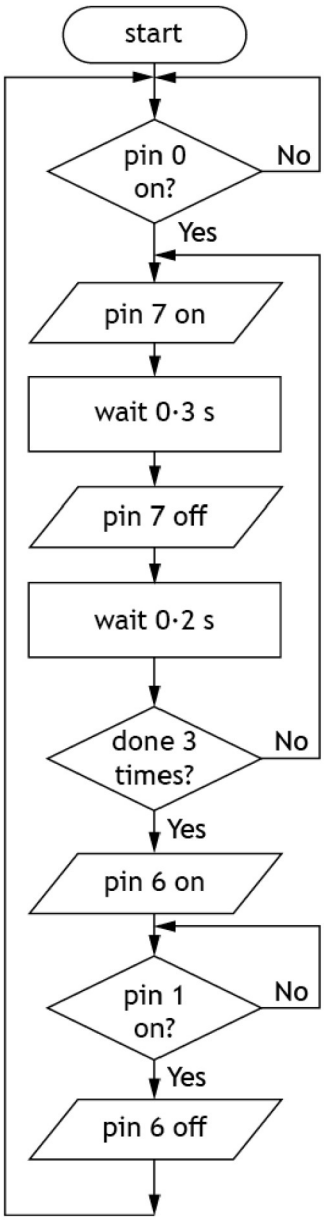
_____

_____

_____

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2022 Question 9: marking instructions

Question			Expected response	Max mark	Additional guidance
9.	(a)			10	Pin 0 on ? with Y/N, loop and arrow in correct position – 1 mark. Pin 7 on and off in correct position - 1 mark. Both delays in correct position (ignore incorrect values and unit) - 1 mark. Total delay time(s) with unit = 0.5 s per cycle - 1 mark. X3 decision with Y/N in correct position – 1 mark. Loop and arrow (x3 decision) back to before pin 7 on – 1 mark. Pin 6 on and off in correct position - 1 mark. Pin 1 on? with Y/N, loop and arrow in correct position – 1 mark. Accept decision feedback loop to before pin 6 on. Continuous loop to start with arrow - 1 mark. All marked symbols correct - 1 mark. Ignore any additional steps. accept on/off repeated 3 times max 2 marks.

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Question			Expected response	Max mark	Additional guidance
9.	(b)		To go back to line 1/main/restart the program To create a continuous loop.	**1**	Descriptive response. 1 mark for looping program back to start. Accept reset the program. Do not accept go to main on its own.
	(c)		The program loops back to line 1/main/"let count = 0"/wrong line ...therefore it will reset the count/ the count will not pass 1/count will not reach 20.	**2**	1 mark for program looping back to the line 1 (cause). 1 mark for resetting the count (effect).

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2022 Question 14 (c)

N5 Engineering Science 2022 paper, Section 2, Question 14 (c). Total: 1 marks

A microcontroller is used in the control of the hydropower station.

(c) Describe one **advantage** of using a microcontroller instead of a hard wired circuit. 1

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2022 Question 14 (c): marking instructions

Question			Expected response	Max mark	Additional guidance
	(c)		The program can be easily modified/ corrected It is reprogrammable Its more reliable because there are less components	1	Descriptive response relating to when in use. Do not accept cheaper/fewer components/reliable/quicker on its own. Do not accept easier/quicker to replace component.

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2023 Question 8 (a)

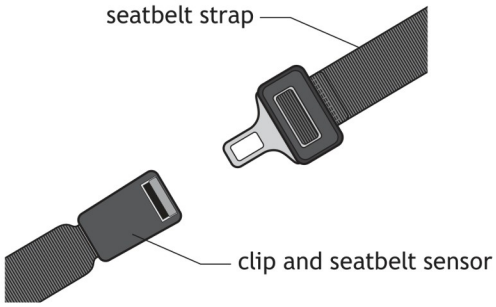
N5 Engineering Science 2023 paper, Section 2, Question 8 (a). Total: 10 marks

DO NOT WRITE IN THIS MARGIN

SECTION 2 — 90 marks

Attempt ALL questions

8. A car safety system detects when the driver's seatbelt is unfastened.



The safety system is operated by a microcontroller.

Input and output connections to the microcontroller are shown in the table below.

Input connections	Pin	Output connections
	7	warning lamp
	6	buzzer
seatbelt sensor	0	

The safety system operates using the following sequence:

- A warning lamp and a buzzer turn off.
- When the seatbelt sensor is on, the sequence will return to the start.
- If the seatbelt sensor is off, the warning lamp will turn on.
- The buzzer will then turn on and off three times over a total period of 1.8 seconds.
- The sequence will return to check the seatbelt sensor again.

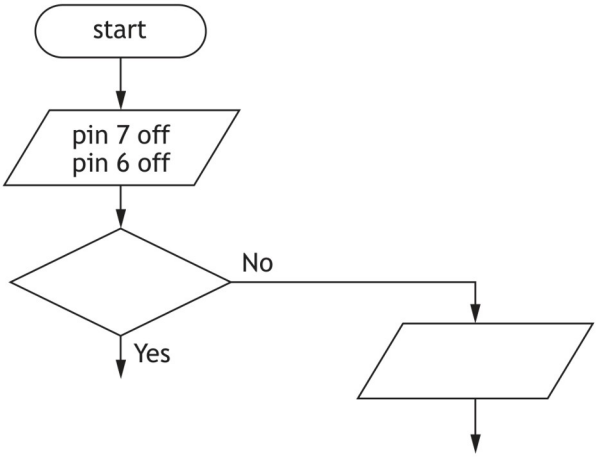
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MARKS | DO NOT WRITE IN THIS MARGIN

8. (continued)

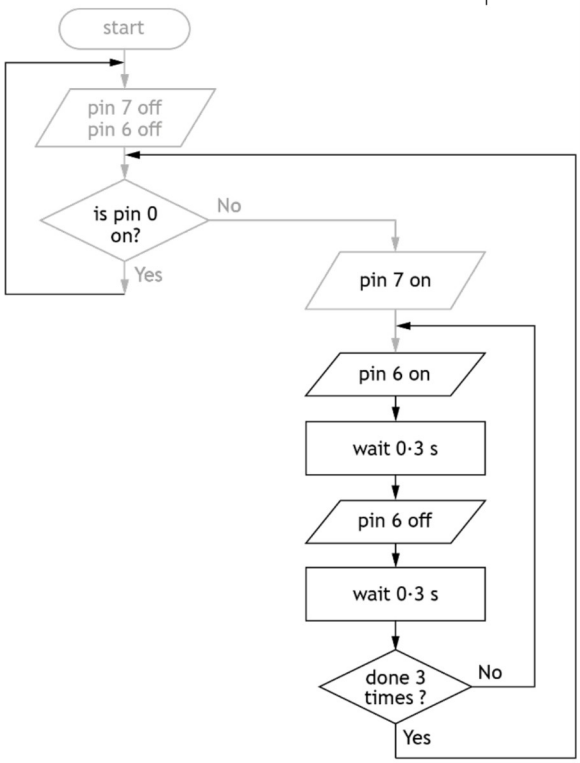
(a) Complete the flowchart for the sequence shown opposite, with reference to the Data Booklet and input/output connections.

Include **all** pin numbers and delay units in your flowchart. **10**



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2023 Question 8 (a): marking instructions

Question			Expected response	Max mark	Additional guidance
8.	(a)			10	Pin 0 on ? decision – 1 mark. Yes loop to start (arrow provided) – 1 mark. Pin 7 on in correct position – 1 mark. Pin 6 on **and** off in correct position – 1 mark. Both delays in correct position – 1 mark. Total delay time with unit = 0.6 s - 1 mark. x3 ? decision with Y/N – 1 mark. Correct repeat sequence loop with arrow back to before pin 6 on – 1 mark. Loop after sequence with arrow back to before pin 0 – 1 mark Accept (on, off, delay) sequence repeated three times – 2 marks. All symbols correct – 1 mark. Ignore any additional steps.

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2023 Question 9 (c) and (d)

N5 Engineering Science 2023 paper, Section 2, Question 9 (c) and (d). Total: 3 marks

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

A microcontroller based system is used to detect the bottles.

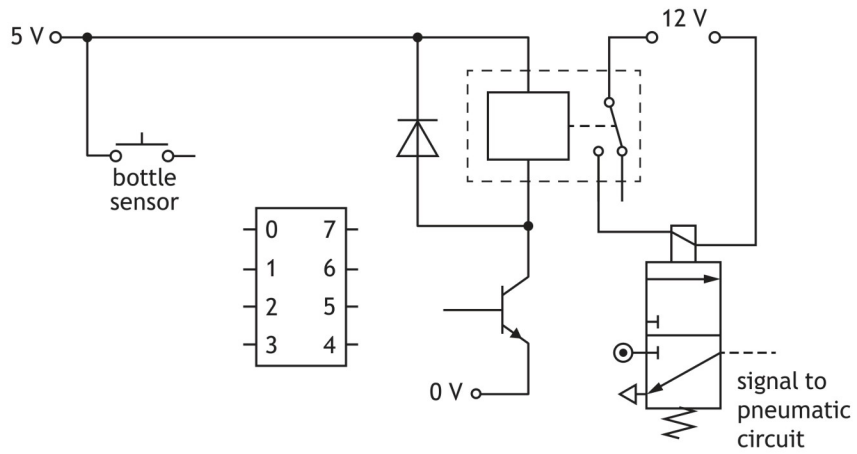
The program used to count six bottles is shown below.

line	program	
1	main:	let count = 0
2	check:	if input2 is off then check
3		let count = count + 1
4		if count = 6 then label_1
5		goto check
6	label_1:	switch on 7
7		pause 500
8		switch off 7
9		goto main

(c) State the **line number** that contains a time delay. **1**

An incomplete diagram for the microcontroller based system is shown below.

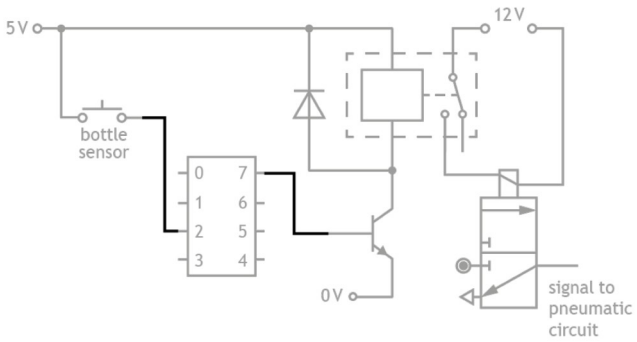
(d) Complete, with reference to the program above, the wiring of the bottle sensor and the transistor to the microcontroller. **2**



[Turn over

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2023 Question 9 (c) and (d): marking instructions

Question			Expected response	Max mark	Additional guidance
	(c)		(Line) 7	1	
	(d)			2	Bottle sensor correctly wired to pin 2 – 1 mark. Pin 7 correctly wired to base of transistor – 1 mark. Do not accept any additional pins wired to bottle sensor/transistor.

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2024 Question 11 (b)

N5 Engineering Science 2024 paper, Section 2, Question 11 (b). Total: 11 marks

MARKS | DO NOT WRITE IN THIS MARGIN

11. (continued)

The dishwasher is operated by a microcontroller.

Input and output connections to the microcontroller are shown in the table below.

Input connection	Pin	Output connection
	7	red LED
	6	water pump
	5	heating element
	4	buzzer
	3	
start switch	2	
door sensor	1	
	0	

A drying cycle used in the dishwasher operates using the following sequence:

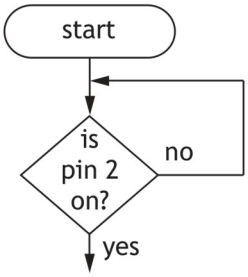
- When a start switch is pressed a red LED will turn on.
- After a door sensor is activated a water pump will turn on for 35 seconds and then turn off.
- A heating element will then turn on for 5 minutes and then turn off.
- A buzzer will then sound six times, turning on for 0.3 seconds and turning off for 0.3 seconds each time.
- The red LED will then turn off.
- The sequence will return to the start.

(b) Complete the flowchart shown opposite for the sequence with reference to the data booklet and input/output connections.

Include **all** pin numbers and delay units in your flowchart. **11**

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11. (b) (continued)

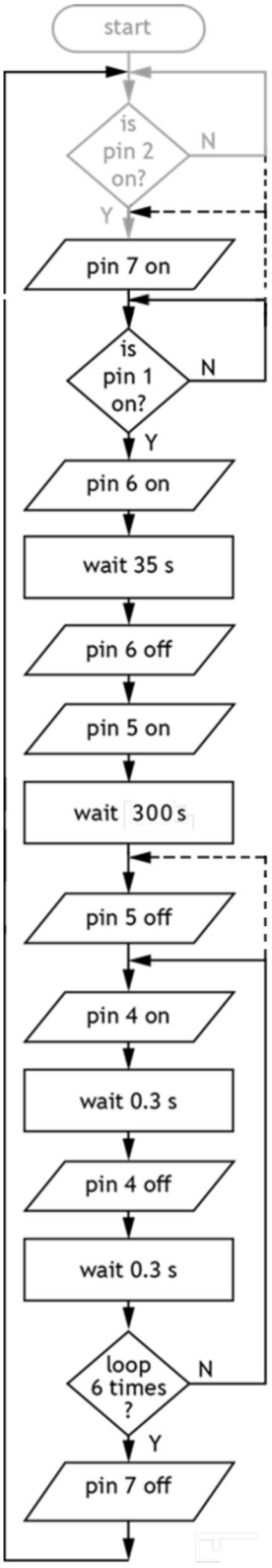


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2024 Question 11 (b): marking instructions

Question			Expected response	Max mark	Additional guidance
11.	(b)			11	Pin 7 on and off in correct position - 1 mark. Pin 1 on? with y/n - 1 mark. Pin 1 loop back with arrow before decision - 1 mark. Pin 6 on and off in correct position - 1 mark. Pin 5 on and off in correct position - 1 mark. Pin 4 on and off in correct position - 1 mark. All four delay times with correct units - 1 mark. Accept 5 minutes rather than 300 s. Loop x 6? with y/n - 1 mark. Feedback loop and arrow to before pin 4 on - 1 mark. Continuous loop and arrow to start of program - 1 mark. All symbols correct - 1 mark. Ignore any additional steps including their symbols.

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2025 Question 2

N5 Engineering Science 2025 paper, Section 1, Question 2. Total: 3 marks

MARKS | DO NOT WRITE IN THIS MARGIN

2. A microcontroller program is shown.

line	program	
1	`main:`	`if input1 is on then label_1`
2		`goto main`
3	`label_1:`	`let count = 0`
4	`label_2:`	`switch on pin 7`
5		`pause 500`
6		`switch off pin 7`
7		`pause 500`
8		`let count = count + 1`
9		`if count = 15 then label_3`
10		`goto label_2`
11	`label_3:`	`end`

(a) State a line number that contains a time delay. **1**

Line number _____

(b) State the number of times that pin 7 will turn on and then off. **1**

_____

(c) State the name of the type of loop used to control the number of times pin 7 turns on and off. **1**

_____

[Turn over

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2025 Question 2: marking instructions

Question			Expected response	Max mark	Additional guidance
2.	(a)		(Line) 5 or 7	**1**	Only a single line number required. Accept the line number indicated on the program.
	(b)		15 (times)	**1**	
	(c)		Fixed/ Finite (loop)	**1**	

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2025 Question 8 (c)

N5 Engineering Science 2025 paper, Section 2, Question 8 (c). Total: 2 marks

The pneumatic circuit is modified to be operated by a microcontroller.

(c) Explain why the use of a microcontroller is advantageous in this situation. **2**

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2025 Question 8 (c): marking instructions

Question			Expected response	Max mark	Additional guidance
	(c)		The microcontroller program can be easily updated/reprogrammed …without needing to change the pneumatic circuit. A microcontroller would need fewer (pneumatic) components ….reducing the cost of the circuit. The microcontroller program will allow a set number of piston movements …allowing accurate test results to predict performance.	**2**	Descriptive response relating to a positive reason for using a microcontroller in the context of a pneumatic circuit. 1 mark for cause. Do not accept easier to change on its own. 1 mark for effect.

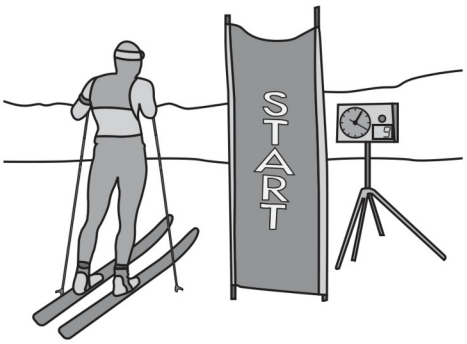
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2025 Question 9

N5 Engineering Science 2025 paper, Section 2, Question 9. Total: 13 marks

DO NOT WRITE IN THIS MARGIN

9. A skiing competition has each competitor starting the race with 1 minute intervals between them.



A microcontroller is used to control the starting signal for each competitor.

The sequence used is shown below.

1. A red lamp is turned on.
2. A start switch is activated.
3. The red lamp turns off and a buzzer turns on.
4. After a 0.5 second delay, the buzzer turns off and the red lamp turns on.
5. There is a 1 minute delay.
6. Steps 3 to 5 are repeated 50 times.
7. The red lamp turns off and the sequence ends.

Input and output connections to the microcontroller are shown in the table below.

Input connection	Pin	Output connection
	7	red lamp
	6	buzzer
start switch	1	

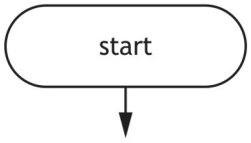
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MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(a) Complete the flowchart for this sequence, with reference to the data booklet and input/output connections shown opposite.

Include **all** pin numbers and the delay units in your flowchart. **10**

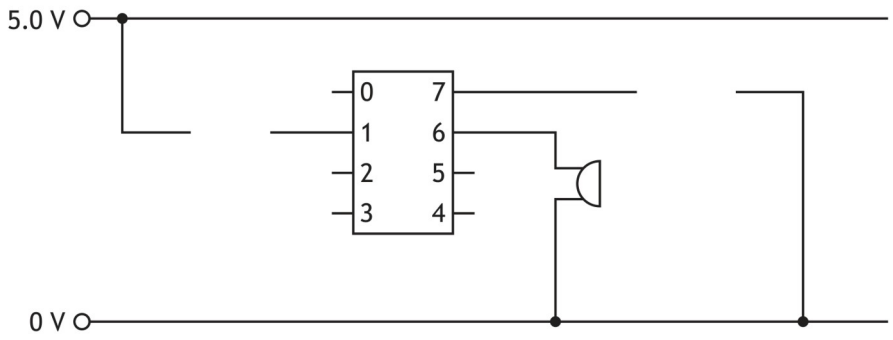


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MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

An incomplete microcontroller wiring diagram used to test the sequence is shown below.



(b) Complete the wiring diagram with reference to the input/output table shown below. **2**

Input connection	Pin	Output connection
	7	red lamp
	6	buzzer
start switch	1	

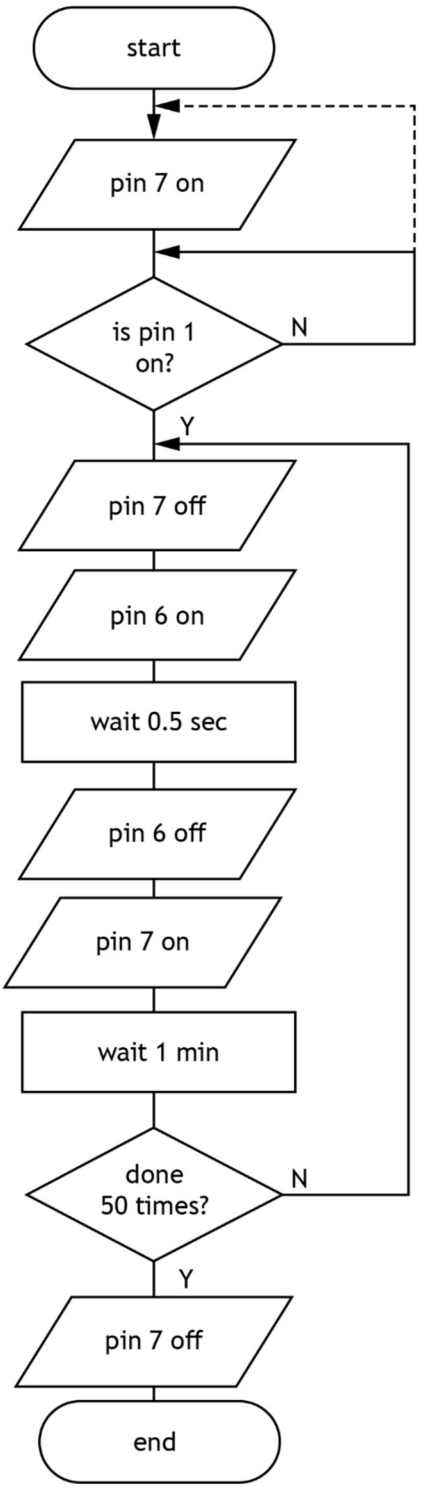
During testing it was found that the lamp was not bright enough.

(c) State the name of an electronic component that could be added to cause the lamp to turn on brightly when the pin is switched on. **1**

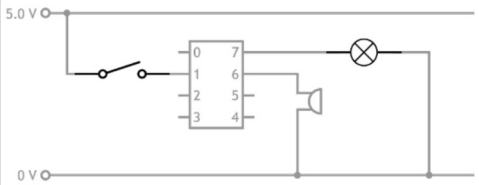
_____

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2025 Question 9: marking instructions

Question			Expected response	Max mark	Additional guidance
9.	(a)			10	1 mark - (FIRST) Pin 7 on and off in correct position. 1 mark - Pin 1 on? with Y/N, loop and arrow in correct position. 1 mark - Pin 6 on and off in correct position. 1 mark - 0.5s delay in correct position with unit. 1 mark - (SECOND) Pin 7 on and off in correct position. 1 mark – 1 min (60s) delay in correct position with unit. 1 mark - x50 decision with Y/N in correct position. 1 mark - Loop with arrow (x50 decision) back to between pin 1 on and pin 7 off. 1 mark – end (stop). 1 mark - all correct symbols. Ignore any additional steps including their symbols.

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Question			Expected response	Max mark	Additional guidance
9.	(b)			**2**	1 mark for switch symbol wired between 5 V and pin 1. Accept push to make switch. 1 mark for lamp symbol wired between pin 7 and 0 V.
	(c)		Transistor	**1**	Accept relay (switch)/MOSFET. Do not accept driver.

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2026 Question 12 (a)

N5 Engineering Science 2026 paper, Section 2, Question 12 (a). Total: 10 marks

DO NOT WRITE IN THIS MARGIN

12. An electric toothbrush is shown.



The electric toothbrush is operated by a microcontroller.

Input and output connections to the microcontroller are shown in the table below.

Input connection	Pin	Output connection
	5	LED
	4	motor
battery level sensor (charged = 1)	2	
start switch	1	

The electric toothbrush operates using the following sequence:

- When the start switch is pressed, the battery level sensor is checked. If it is not pressed, the motor will be off.
- If the battery level is charged, the motor will turn on and the sequence will return to the start.
- If the battery level is not charged, the LED will turn on for 0.5 seconds and off for 0.4 seconds. This will repeat twenty times.
- The sequence will then return to the start.

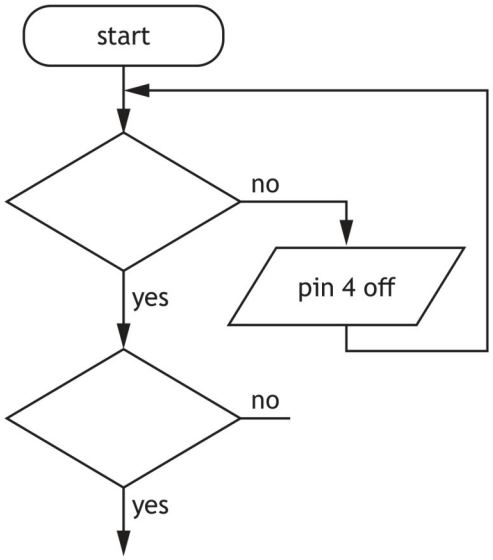
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MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

(a) Complete the flowchart for the sequence shown opposite, with reference to the data booklet and input/output connections.

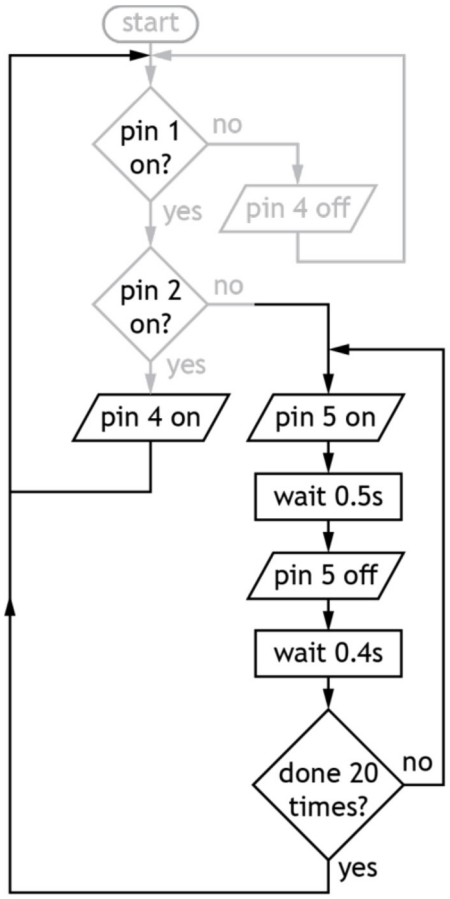
Include **all** pin numbers and the delay unit in your flowchart. **10**



[Turn over

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2026 Question 12 (a): marking instructions

Question			Expected response	Max mark	Additional guidance
12.	(a)			10	Each decision must include a question mark. If 1/0 is used rather than on/off, then an equal sign is required. If flowchart is redrawn then the yes/no routes and arrows must match that given. **1 mark** - Pin 1 on? decision in correct position. **1 mark** - Pin 2 on? decision in correct position. **1 mark** - Pin 4 on in correct position. **1 mark** - loop after pin 4 on back to start with arrow. **1 mark** - Pin 5 on **and** off in correct position. **1 mark** - 0.5s **and** 0.4s delay with Unit. **1 mark** - x 20? decision with Y/N. **1 mark** – decision no route with arrow to before pin 5 on. **1 mark** – decision yes route with arrow back to start. **1 mark** - all drawn symbols correct. Ignore any additional steps.

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2026 Question 13 (e)

N5 Engineering Science 2026 paper, Section 2, Question 13 (e). Total: 2 marks

The air source heat pump is operated by a microcontroller.

(e) Describe two advantages of **using** a microcontroller compared to a hard-wired electronic circuit in the operation of the air source heat pump. **2**

1. _____

_____

2. _____

_____

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2026 Question 13 (e): marking instructions

Question			Expected response	Max mark	Additional guidance
	(e)		Air source heat pump will be more reliable with a microcontroller (less components that could fail). It would be easier to fault find with a microcontroller (as an error code could be displayed). The air source heat pump control software can be reprogrammed/ updated (to improve efficiency). A hardwired electronic control circuit would be more difficult to update (remotely).	**2**	Descriptive response must relate to a positive advantage of microcontroller use in the operation of the air source heat pump. **1 mark** for each description. Do not accept description of initial programming of microcontroller. Marks can be awarded for maintenance related advantages but not installation/manufacture. Do not accept easier to replace parts on its own.

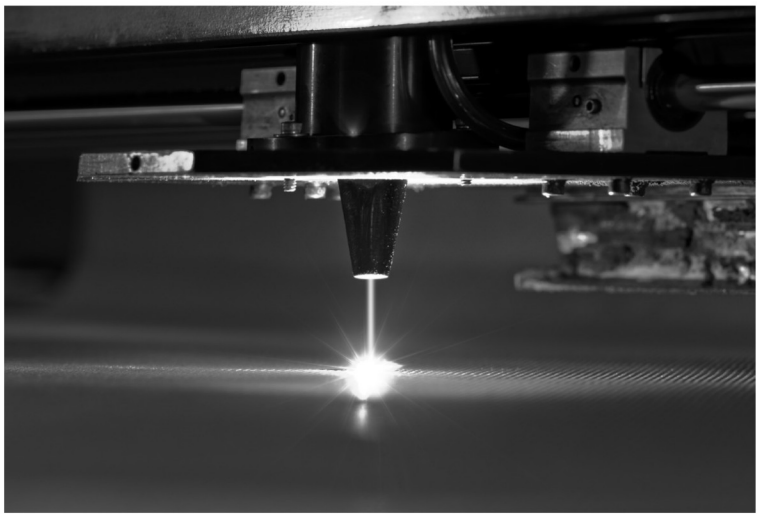
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Specimen Question 13 (a)

N5 Engineering Science Specimen paper, Section 2, Question 13 (a). Total: 7 marks

13. A laser cutting machine is used to cut sheet steel, as shown in the photograph below.

DO NOT WRITE IN THIS MARGIN



The laser is positioned by motors A and B which are operated by a microcontroller.

Input and output connections to the microcontroller are shown in the table below.

Input connection	Pin	Output connection
	7	Motor A forward (move right)
	6	Motor A reverse (move left)
	5	Motor B forward (move forward)
	4	Motor B reverse (move back)
	3	Laser (on when high, off when low)
	2	
	1	
	0	

The cutter is required to perform the following sequence of operations:

1: Switch on the laser

2: Move right for 0·5 seconds

3: Move forward for 0·5 seconds

4: Repeat steps 2 and 3 four times

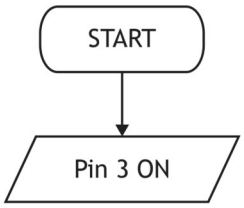
5: Switch off laser and motors

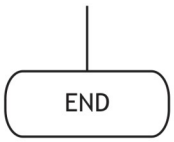
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MARKS | DO NOT WRITE IN THIS MARGIN

13. (continued)

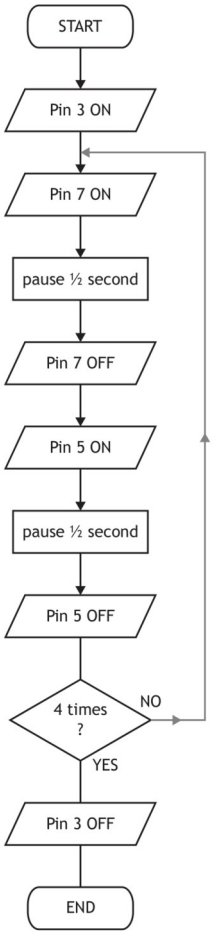
(a) Complete, with reference to the data booklet and input/output connections, the flowchart for the control sequence. Include **all** pin numbers. **7**





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Specimen Question 13 (a): marking instructions

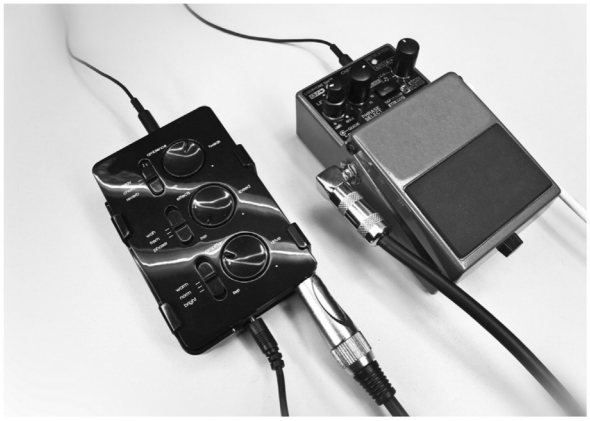
Question			Expected response	Max mark	Additional guidance
13	a			7	1 mark for all symbols used correctly 1 mark for feedback loop with arrows 1 mark for decision including yes/no 1 mark for both pause commands 1 mark for PIN 3 ON and OFF 1 mark for PIN 7 ON and OFF 1 mark for PIN 5 ON and OFF

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Specimen Question 14 (d)

N5 Engineering Science Specimen paper, Section 2, Question 14 (d). Total: 2 marks

An "effects pedal", as shown in the photograph below, can be attached to the guitar to change the sound produced. The effects pedal uses complex electronic circuitry.



(d) Explain why a microcontroller might be used in place of a hard wired circuit in the effects pedal. **2**

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Specimen Question 14 (d): marking instructions

Question			Expected response	Max mark	Additional guidance
14	d		Any valid point with explanation, such as: • reduced size • quicker assembly • reduced cost, etc … due to fewer components	2	

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- 2015 paper, Section 2, Question 15 (a) and (b) and its marking instructions
- 2016 paper, Section 1, Question 2 and its marking instructions
- 2016 paper, Section 2, Question 12 (c) and its marking instructions
- 2017 paper, Section 2, Question 9 and its marking instructions
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