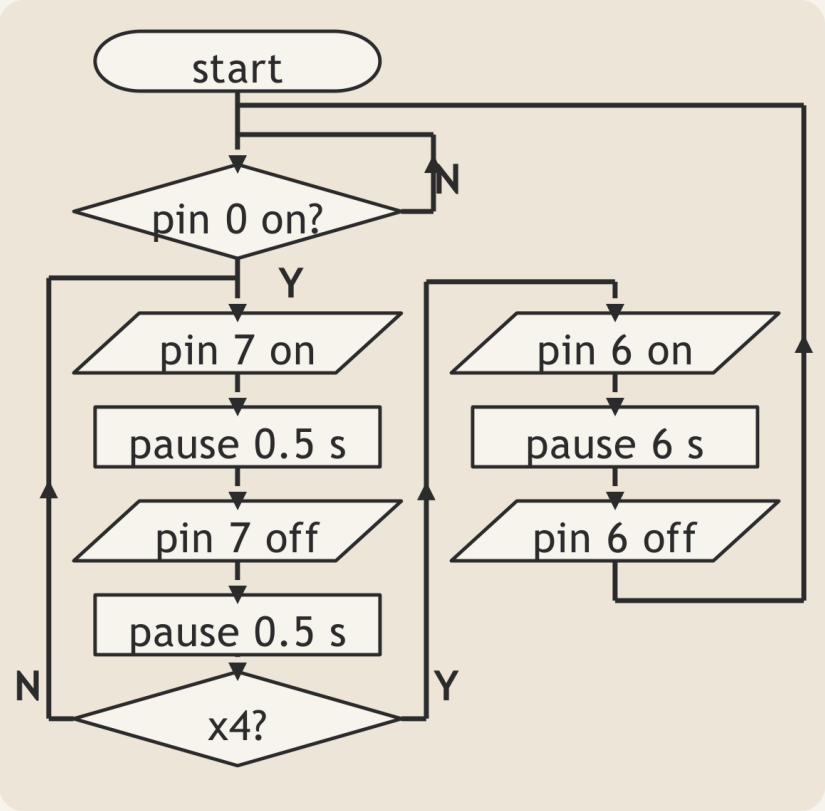
Daily Review



1. **State** what a microcontroller **runs**.
2. **State** one **advantage** of a microcontroller.
3. A switch is pressed. **State** its pin **voltage**. (**value and unit**)
4. **Name** the **part** that drives a **motor**.
5. **State** the **marks** for '**driver**' alone.

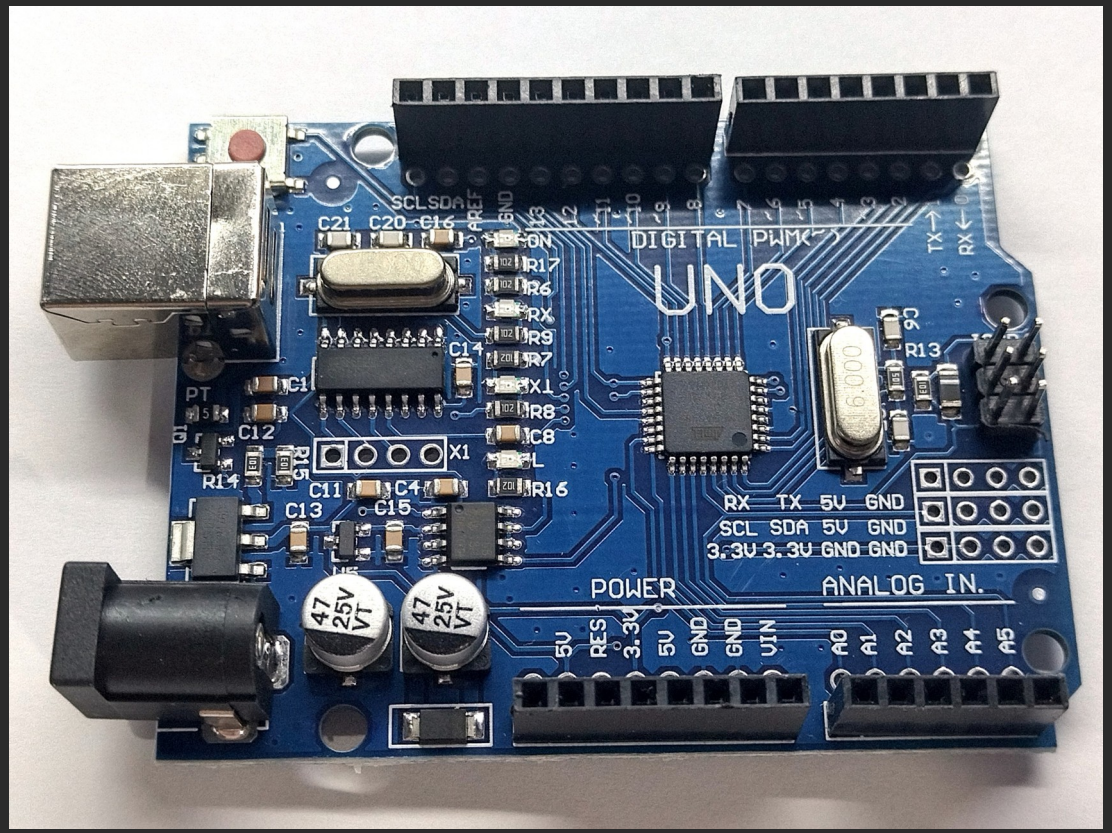
Flowcharts

How do you tell a chip what to do, and when?



National 5 Engineering Science

How do you tell a chip: flash the lamp 3 times, then wait for the button?



PART 1

Symbols and Structures

Six symbols. Four ways to put them together.

By the end of this part...



1. I can **identify** the six **flowchart symbols**
2. I can **describe** a **continuous loop** and a **fixed loop**
3. I can **describe** a **time delay** and a **branch**

What a Flowchart Is

A flowchart

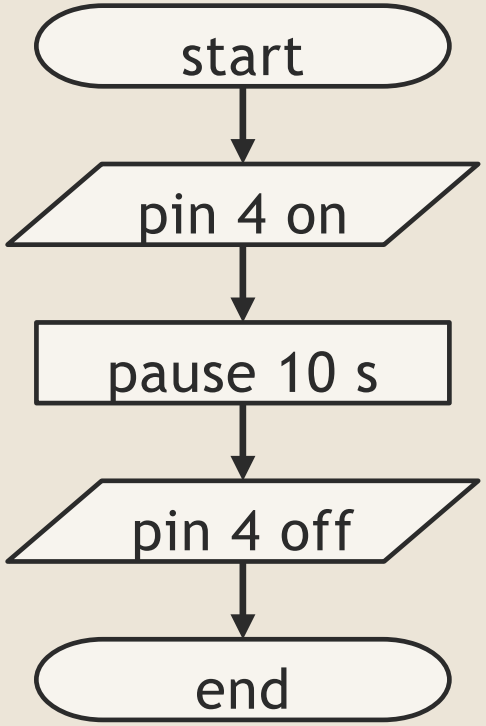
the steps of a program, in order

Each step

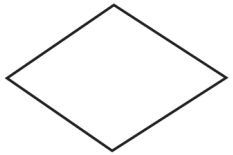
one box

The lines

show the order



The Six Symbols

Terminator symbol		Used for the start and end of a main program or sub-procedure.
Line symbol		Shows the direction of program flow. For flow down or to the right, an arrow is not needed. For flow upwards or to the left, arrows are added.
Input/Output		Used to control outputs or to show that data is being received.
Process symbol		Used for operations which take place within the microcontroller, for example a delay.
Decision symbol		Program flow is determined by a “yes” or “no” answer to the question in the box.
Sub procedure symbol		Used to call a sub-procedure.

Lines and Arrows

Down or right

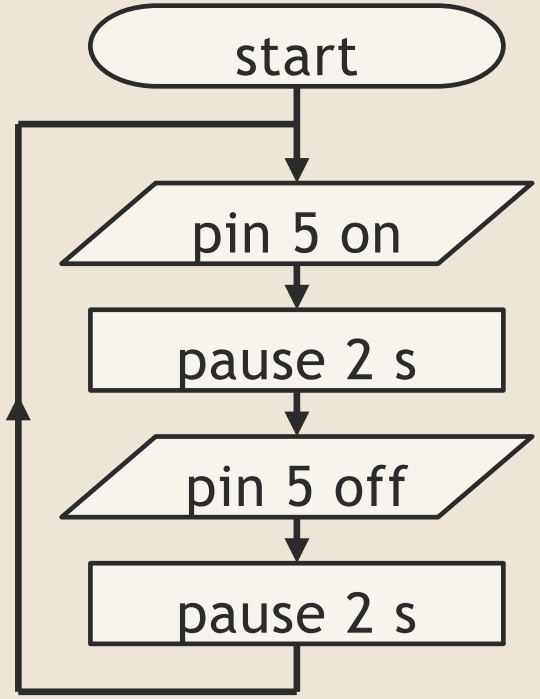
an arrow is not needed

Up or left

an arrow is needed

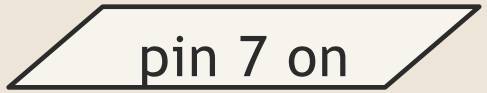
Every loop back

give it an arrow: it earns a mark

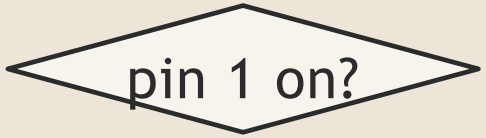


What Goes in the Box

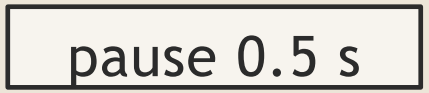
Output



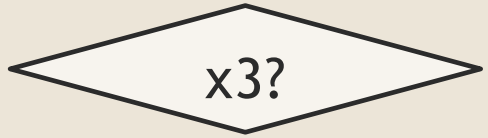
Input



Delay



Fixed loop



Always a pin number. Always a unit.

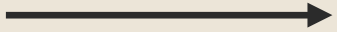
The booklet writes: Lamp (output, pin 13) ON · Wait 1 s (1000 ms) · count < 5?

Name the Symbol

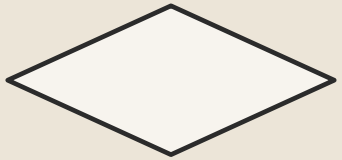
1



2



3



4



5



6



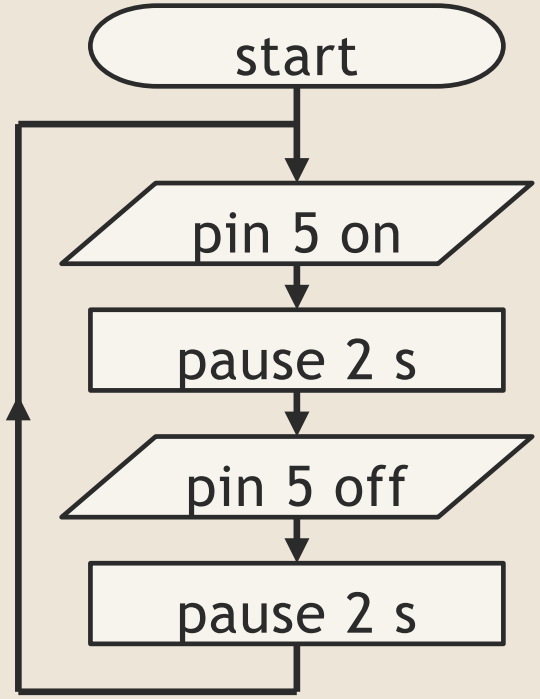
Continuous Loop

Repeats

forever, until the power goes off

Drawn as

a line back up, with an arrow



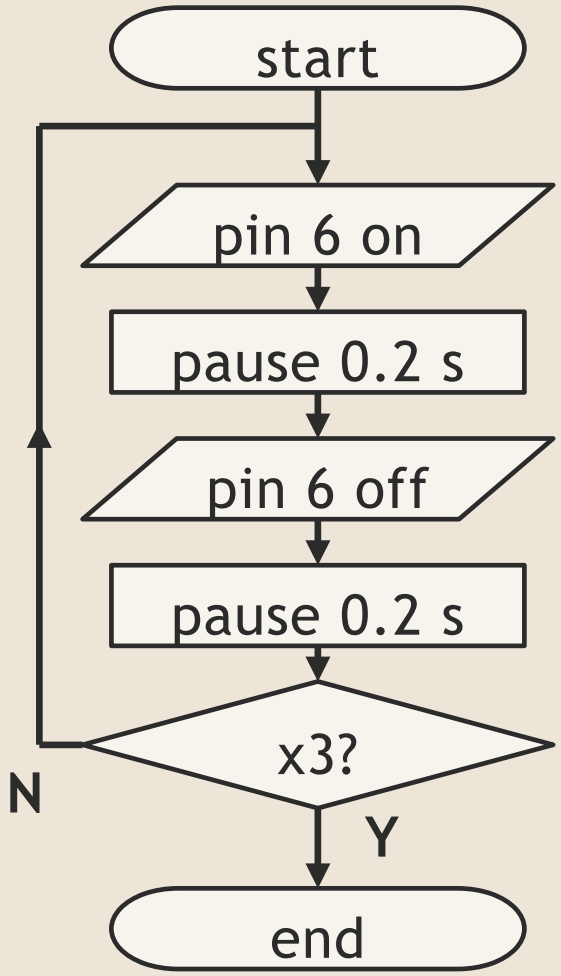
Fixed Loop

Repeats

a set number of times, then moves on

Drawn as

a decision, x3?. N goes back up.



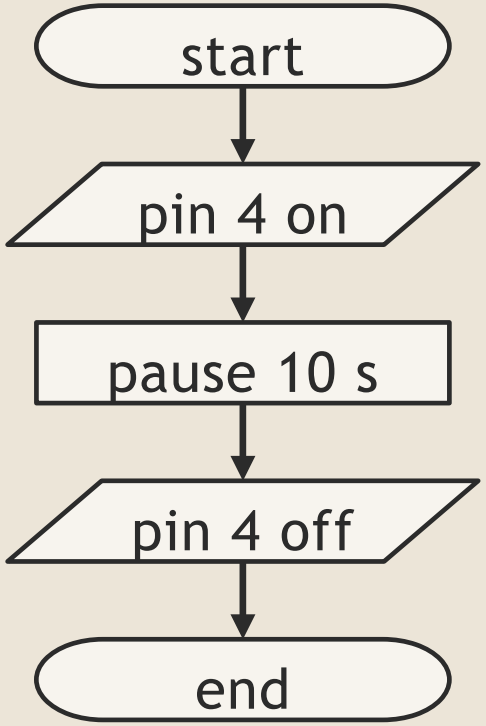
Time Delay

A pause

the program waits for a set time

Meanwhile

outputs stay as they are



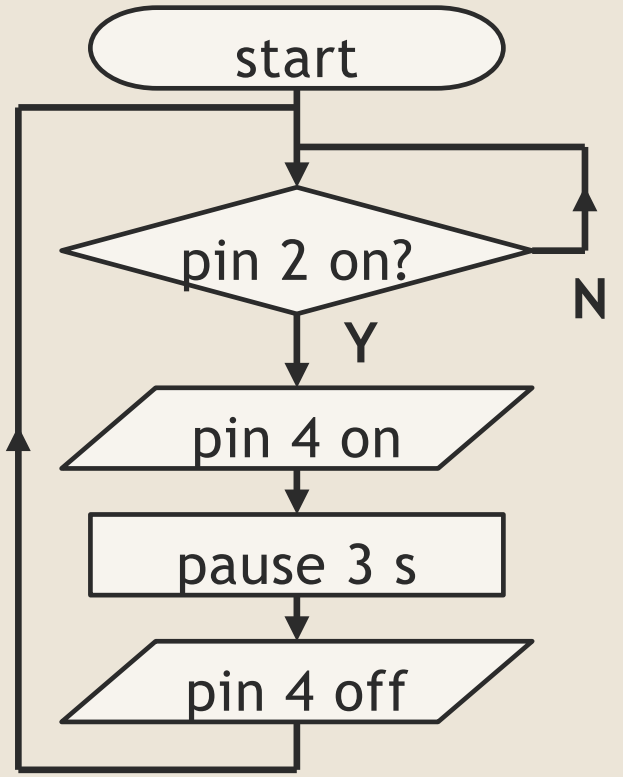
Branch

A decision

yes or no

Each answer

its own path, labelled Y and N



Identify the Programming Structure



1. A pump runs for 5 minutes, then stops. **Identify** the **structure**.
2. A sign flashes all day. **Identify** the **structure**.
3. A bell rings 4 times, then stops. **Identify** the **structure**.

Identify the Programming Structure



4 An alarm sounds if a door opens. **Identify** the **structure**.

5 A fan comes on each time a switch is pressed. **Identify** the **structure**.

PRACTICE: Programming Structures

Q1-6 (B4b-p7)

Answer Q1 to Q6 **on your own.**
One sentence each.

6 min

PRACTICE — Programming Structures

1. State what is meant by a continuous loop. (1)
2. State what is meant by a fixed loop. (1)
3. State what is meant by a time delay. (1)
4. Describe the purpose of a branch in a control program. (1)
5. Identify the programming structure for: a program that flashes a light 6 times and then stops. (1)
6. Identify the programming structure for: a program that watches a temperature sensor forever. (1)

Answers: Programming Structures (B4b-p7)

Question	Answer
1 State: continuous loop	Repeats until the power is removed.
2 State: fixed loop	Repeats a set number of times.
3 State: time delay	It waits; outputs stay the same.
4 Describe: branch	A yes/no decision picks a path.
5 Identify: flash 6 times	A fixed loop.
6 Identify: watch forever	A continuous loop.

Checkpoint



1. **State** the flowchart **symbol** used for a **delay**.
2. **State** which flowchart **lines** need an **arrow**.
3. **Explain** why a control program **loops continuously**.

Plenary: Part 1



1. **Name** the flowchart symbol shaped like a **diamond**.
2. **Name** the symbol used for an **input** or an **output**.
3. **State** what is meant by a **continuous loop**.

Plenary: Part 1

4 **State** the type of loop drawn as **x3?**

5 **Describe** what happens to the **outputs** during a **delay**.

Look back — by the end of this part...



1. I can **identify** the six **flowchart symbols**
2. I can **describe** a **continuous loop** and a **fixed loop**
3. I can **describe** a **time delay** and a **branch**

Daily Review



1. **State** the **shape** of a decision.
2. **State** the symbol for a **delay**.
3. **State** what is meant by a **fixed loop**.
4. **State** when a line needs an **arrow**.
5. **State** the **two labels** a decision needs.

PART 2

The Exam Flowchart

10 or 11 marks, every year. Here is how to earn them.

By the end of this part…



1. I can **complete** a **flowchart** from an **I/O table**
2. I can include every **pin number** and every **unit**
3. I can draw every **decision** with **Y, N, a loop and an arrow**

What the Exam Gives You

1

2

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	

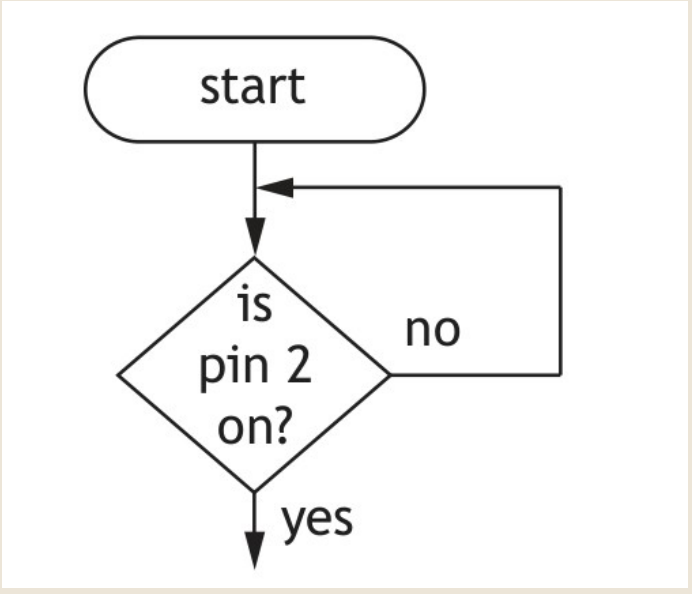
A drying cycle used in the dishwasher operates using the following sequence:

- 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.

1 The table

2 The sequence

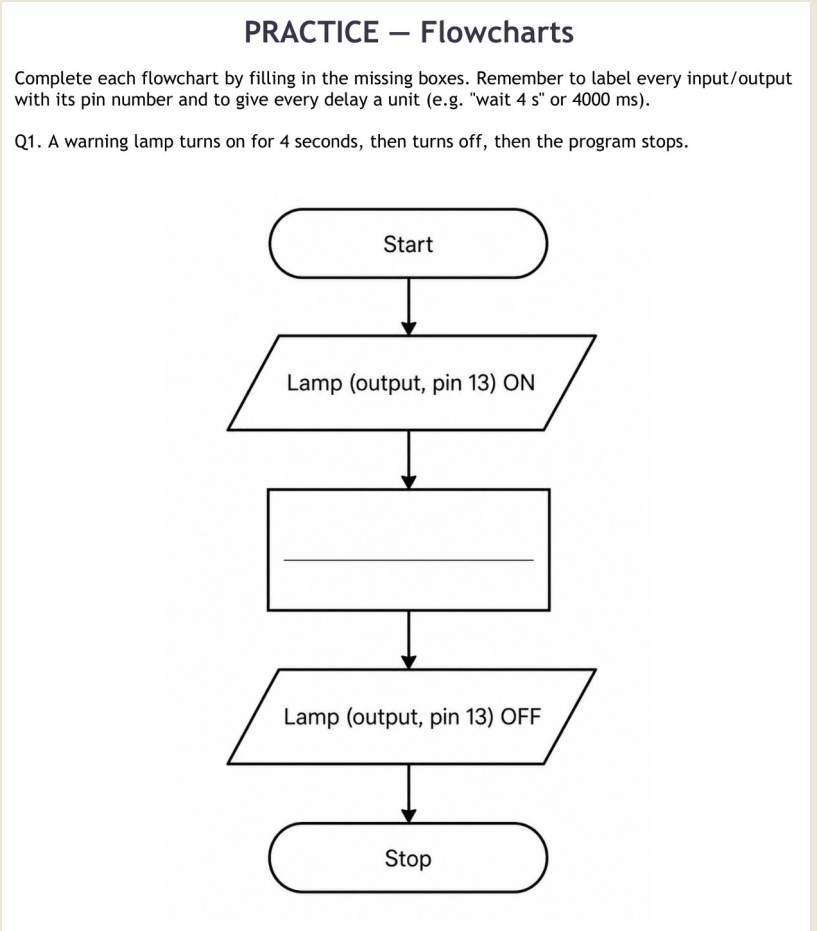
3 The starting point



PRACTICE: Flowcharts

Q1-5 (B4b-p9-13)

Fill in the **missing boxes.**
Every **pin number**. Every **unit.**



Worked Example: The Level Crossing (9 marks)

Input connection	Pin	Output connection
	7	warning lamps
	6	barrier motor
train sensor	0	

Complete the **flowchart** for the sequence.
Include all pin numbers and **delay units.**

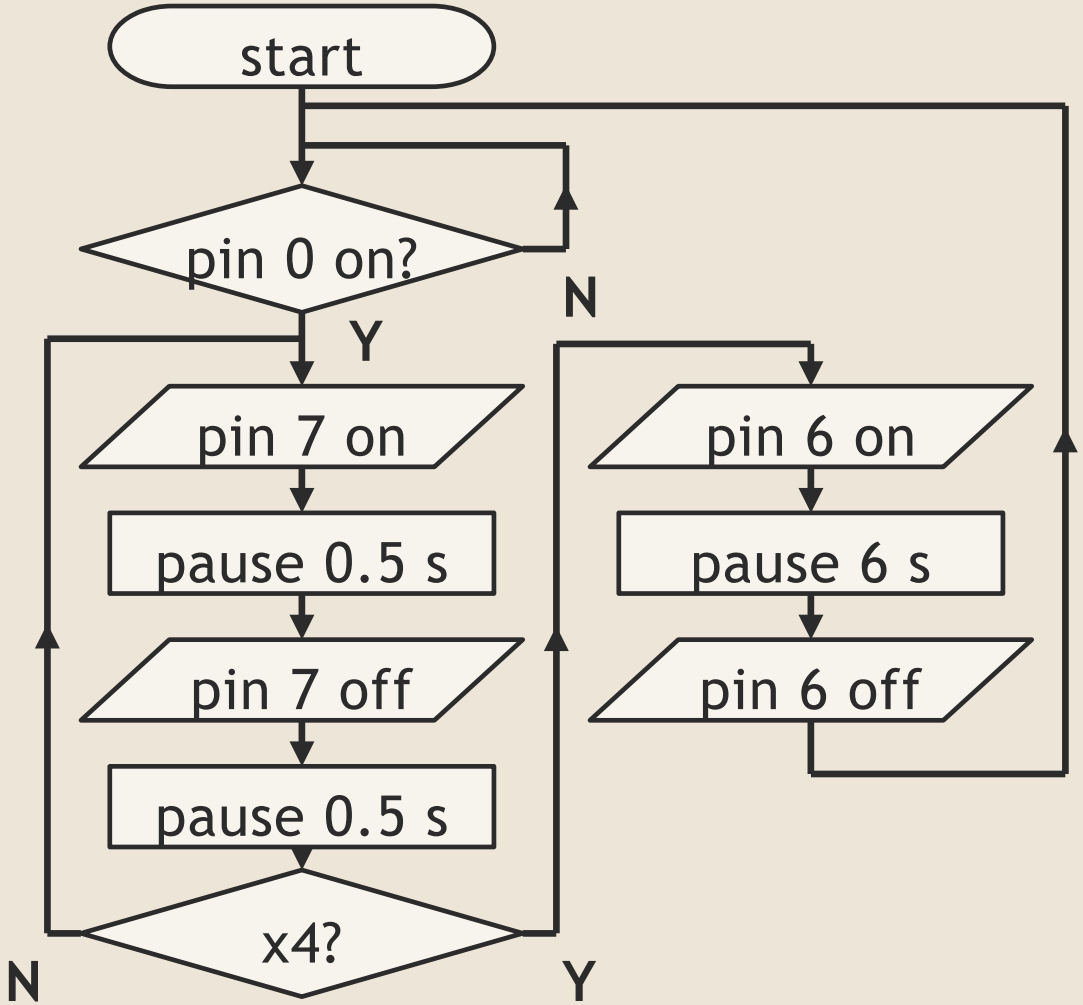
It operates using this sequence:

- When the train sensor is activated, the warning lamps flash four times, turning on for 0.5 seconds and off for 0.5 seconds each time.
- The barrier motor then turns on for 6 seconds and then turns off.
- The sequence returns to the start.

Worked Example: The Flowchart (9 marks)

The sequence, with its pins

1. Train sensor (pin 0) on
2. Lamps (pin 7) flash 4 times: 0.5 s on, 0.5 s off
3. Barrier motor (pin 6) on 6 s, then off
4. Back to the start



Together: The Plant Waterer

Input connection	Pin	Output connection
	7	green LED
	6	water pump
soil sensor	0	

Complete the flowchart by **filling in** the **blank boxes**. **Include all pin numbers** and **delay units**.

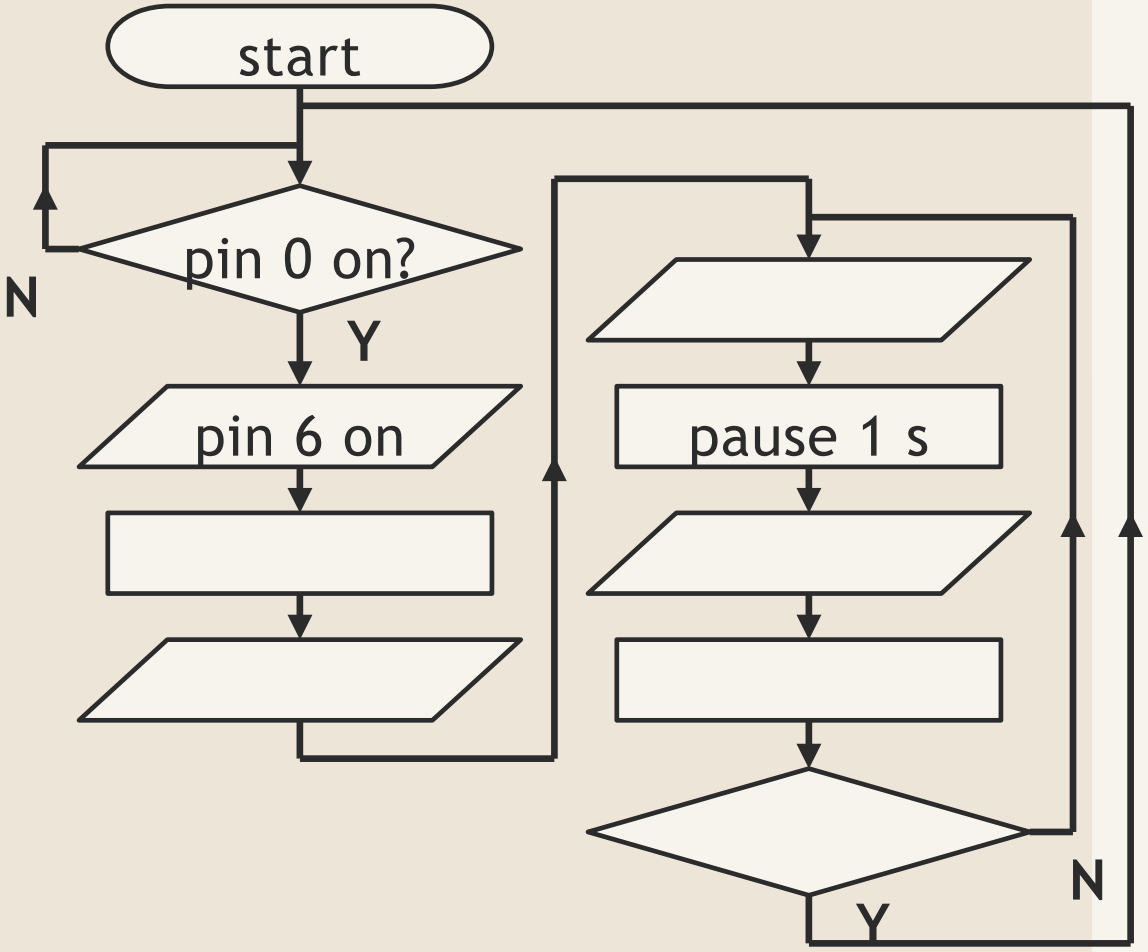
It operates using this sequence:

- When the soil sensor detects dry soil, the water pump turns on for 8 seconds and then turns off.
- A green LED then flashes three times, turning on for 1 second and off for 1 second each time.
- The sequence returns to the start.

Together: Fill In the Blanks

The sequence, with its pins

1. Dry soil: sensor (pin 0) on
2. Water pump (pin 6) on 8 s, then off
3. Green LED (pin 7) flashes 3 times: 1 s on, 1 s off
4. Back to the start



Your Turn: The Car Wash (8 marks)

Input connection	Pin	Output connection
	6	water pump
	5	brush motor
	4	buzzer
start button	1	

Complete the **flowchart** for the sequence.
Include all pin numbers and **delay units**.

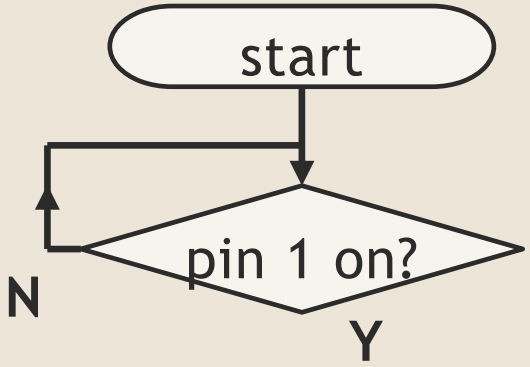
It operates using this sequence:

- When the start button is pressed, the water pump turns on for 20 seconds and then turns off.
- The brush motor then turns on for 30 seconds and then turns off.
- A buzzer then sounds three times, turning on for 0.5 seconds and off for 0.5 seconds each time.
- The sequence returns to the start.

Your Turn: The Flowchart (8 marks)

The sequence, with its pins

1. Button (pin 1) pressed
2. Pump (pin 6) on 20 s, off
3. Brush (pin 5) on 30 s, off
4. Buzzer (pin 4) x3: 0.5 s on, 0.5 s off
5. Back to the start

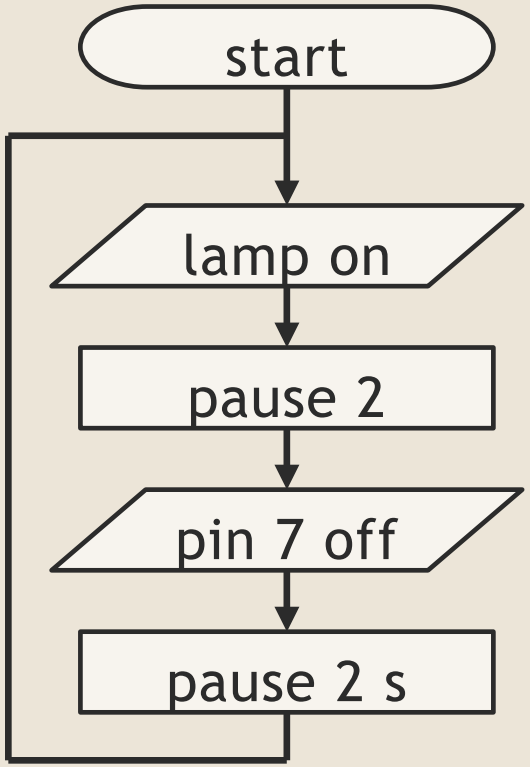


Spot the Mistake: Three Lost Marks

Input connection	Pin	Output connection
	7	lamp

A pupil drew a flowchart for this sequence:

- The lamp turns on for 2 seconds and then turns off for 2 seconds.
- The sequence repeats continuously.



Find the **three mistakes**.
Each one **loses a mark**.

Answers: Flowcharts (B4b-p9-13)

Q	The missing boxes, in order
Q1	Wait 4 s (4000 ms)
Q2	Wait 5 s → Wait 2 s → Buzzer (pin 8) OFF
Q3	LED (pin 13) ON → Wait 1 s → LED (pin 13) OFF → Wait 1 s
Q4	Pressed? → Buzzer (pin 8) ON for 2 s → Buzzer (pin 8) OFF
Q5	count = 0 → LED ON → Wait 0.5 s → LED OFF → Wait 0.5 s → count = count + 1 → count < 5?

Checkpoint



1. **State** what every **output box** must include.
2. **State** what a **delay** must include.
3. **Explain** why a **loop back** needs an **arrow**.

Plenary: Part 2



1. **Name** the **three things** every exam flowchart question gives.
2. A bullet says 'when the switch is pressed'. **Describe** how to **draw** it.
3. **State** where the **N line** from x3? goes back to.

Plenary: Part 2

4 **State** whether an **extra box** loses a mark.

5 **State two ways** a flowchart can **finish**.

Look back — by the end of this part…



1. I can **complete** a **flowchart** from an **I/O table**
2. I can include every **pin number** and every **unit**
3. I can draw every **decision** with **Y, N, a loop and an arrow**

Daily Review



1. **State** what every **output box** must include.
2. **State** what every **delay** must include.
3. **State** what a **loop back** must have.
4. **State** the loop drawn as **x3?**
5. **Name** one exam **starting point.**

PART 3

Build It, Test It

Draw it, then make it run.

By the end of this part…



1. I can **build** a flowchart in **NoSyntaxSim** and **test** it
2. I can build the same flowchart in **Yenka**
3. I can answer a **past-paper** flowchart question

NoSyntaxSim: Flowchart to Uno

Each box

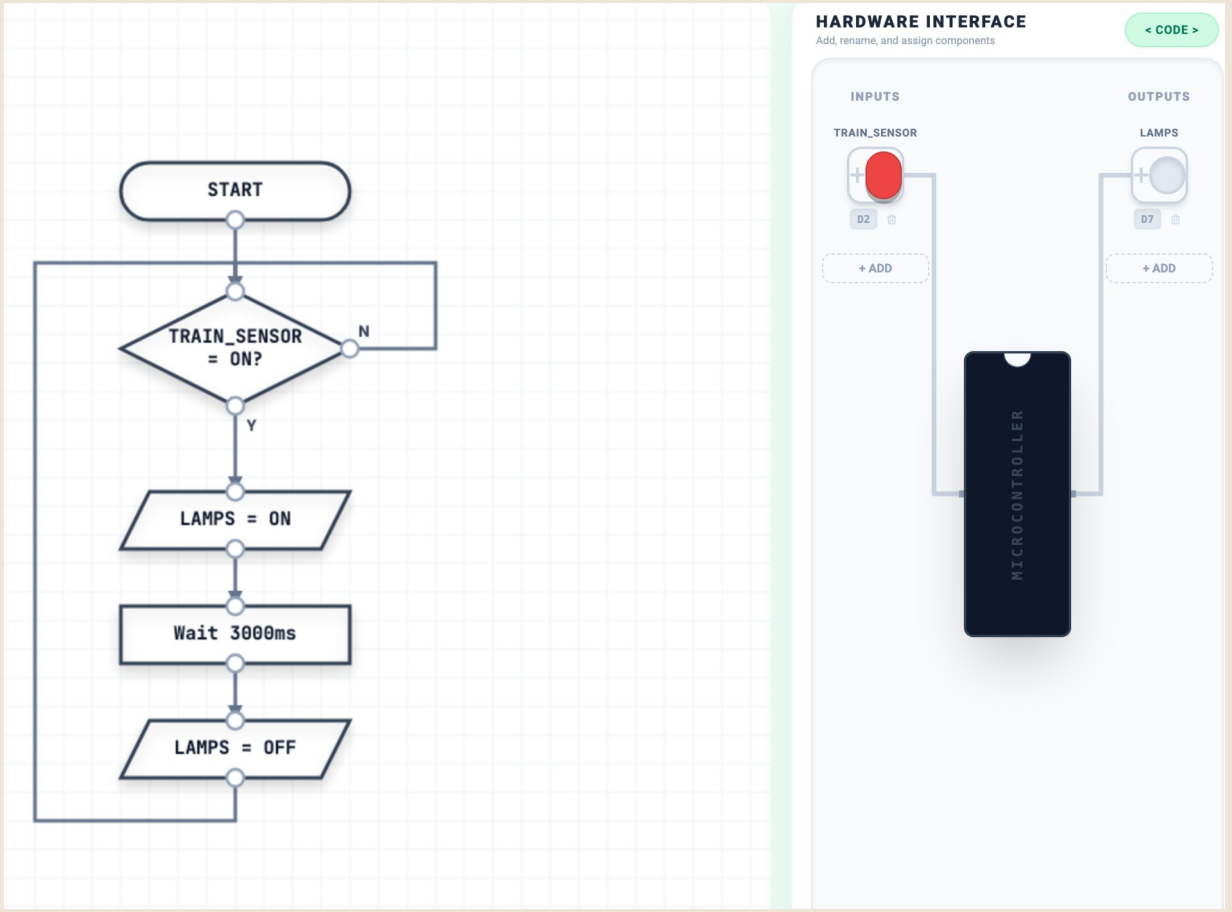
choose its pin

Run Programme

lights up each step as it runs

On paper

write it the exam way: pin 0 on?, pause 3 s



Yenka: The Same Flowchart

Same symbols

same order

Each output

choose its pin

Each wait

set its time and unit

Run it

press the input, watch the output

Build It: 2022 Q9 in Both Simulators

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

Draw it on paper with the **question's pins**. Then **build** it in **NoSyntaxSim**, then **Yenka**.
In NoSyntaxSim: **D2** for pin 0, **D3** for pin 1.

15 min

Past Papers: Flowcharts

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.

2024 Q11(b) (11 marks)

In class

2022 Q9(a), 2024 Q11(b)

Homework

2021 Q13(b), 2023 Q8(a)

2022 Q9(a): The Answer (10 marks)

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



2024 Q11(b): The Answer (11 marks)

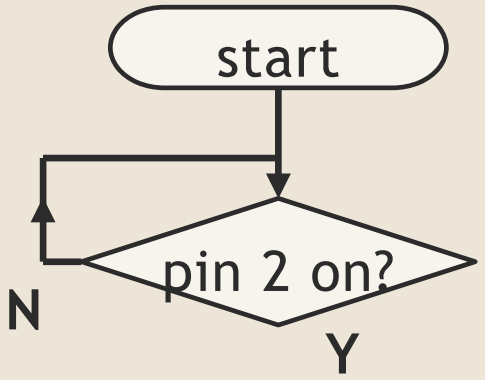
The dishwasher is operated by a microcontroller.

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

Input connection	Pin	Output connection
	7	red LED
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	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.
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- 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.



Plenary: Part 3



1. **State** what you **choose** for each box in **NoSyntaxSim**.
2. **Describe** what **Run Programme** shows.
3. The sim shows 'Wait 3000ms'. **State** what you **write** on paper.

Plenary: Part 3

4 **Describe** how to **test** a **decision** in the simulator.

5 **Name** the **two simulators**.

Extension

EXTRA PRACTICE



1. **Explain** why **x3?** is better than drawing the steps **3 times**.
2. **State** when the **sub-procedure** symbol is used.
3. Two inputs must **both** be on. **State** how many **decisions** are needed.

Look back — by the end of this part…



1. I can **build** a flowchart in **NoSyntaxSim** and **test** it
2. I can build the same flowchart in **Yenka**
3. I can answer a **past-paper** flowchart question

LOOKING AHEAD

Lesson 3: Reading Programs

The exam also writes it as lines of code. Can you read them?

Course Specification

Digital electronic control systems

- using correct symbols (start, stop, input, output, branch and loop) to construct flowcharts showing solutions to simple control programs, involving time delays and continuous and fixed loops

Credits (1 of 3)

The big question (The Uno we use): Photo: JrawX, CC0, via Wikimedia Commons

The Six Symbols (data booklet p.6): © Qualifications Scotland (SQA). N4/N5 Engineering Science Data Booklet, p.6, Symbols for Flowcharts.

PRACTICE: Programming Structures (booklet page): Booklet 4b pages by R Stewart.

What the Exam Gives You (2024 Q11): © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9 and 2024 Q11, question papers and marking instructions.

How the Marks Are Given (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q13(b), 2022 Q9(a), 2023 Q8(a), 2024 Q11(b).

Worked Example: The Level Crossing (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q13(b), 2022 Q9(a), 2023 Q8(a), 2024 Q11(b).

Credits (2 of 3)

Spot the Mistake (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q13(b), 2022 Q9(a), 2023 Q8(a), 2024 Q11(b).

PRACTICE: Flowcharts (booklet page): Booklet 4b pages by R Stewart.

NoSyntaxSim: Flowchart to Uno: NoSyntaxSim V2 screenshot. Simulator by Peter Strain, NoStrainSims (sites.google.com/view/nostrainsim), free and open to all.

Build It: 2022 Q9 (question paper): © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9 and 2024 Q11, question papers and marking instructions.

Past Papers: Flowcharts (2024 Q11): © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9 and 2024 Q11, question papers and marking instructions.

Credits (3 of 3)

2022 Q9(a): The Answer (question paper and marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9 and 2024 Q11, question papers and marking instructions.

2024 Q11(b): The Answer (question paper and marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9 and 2024 Q11, question papers and marking instructions.

Course Specification: © Qualifications Scotland (SQA). Course spec v2.0, p.5

R Stewart - October 2026