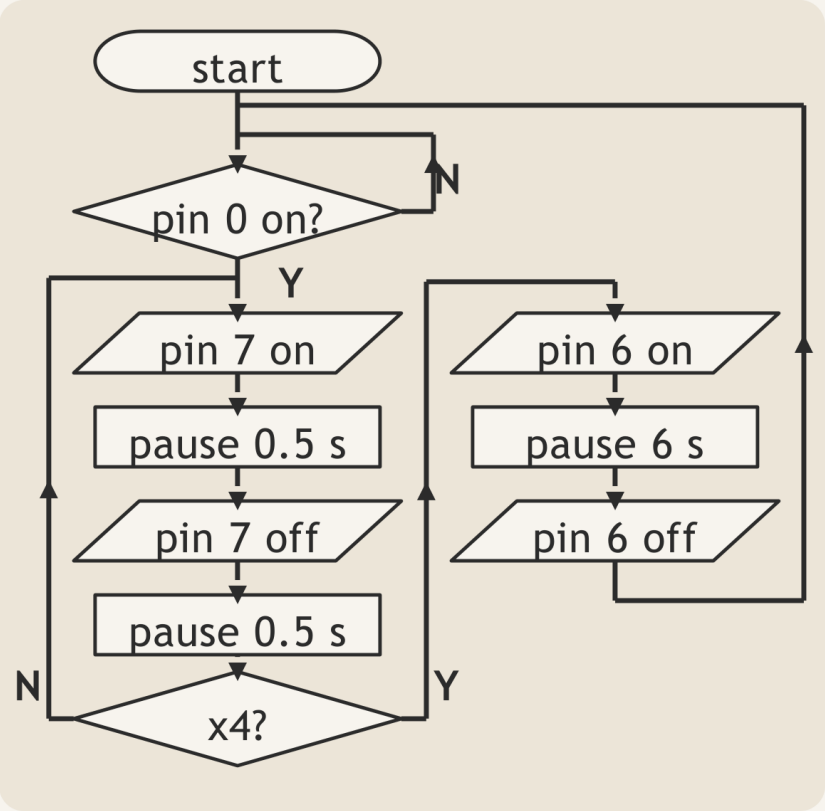
# Daily Review

| | | |
|---|---|---|
| 1 | **State** what a microcontroller **runs**. | A program |
| 2 | **State** one **advantage** of a microcontroller. | It can be reprogrammed |
| 3 | A switch is pressed. **State** its pin **voltage**. (**value and unit**) | 5 V |
| 4 | **Name** the **part** that drives a **motor**. | A transistor |
| 5 | **State** the **marks** for '**driver**' alone. | 0 marks |

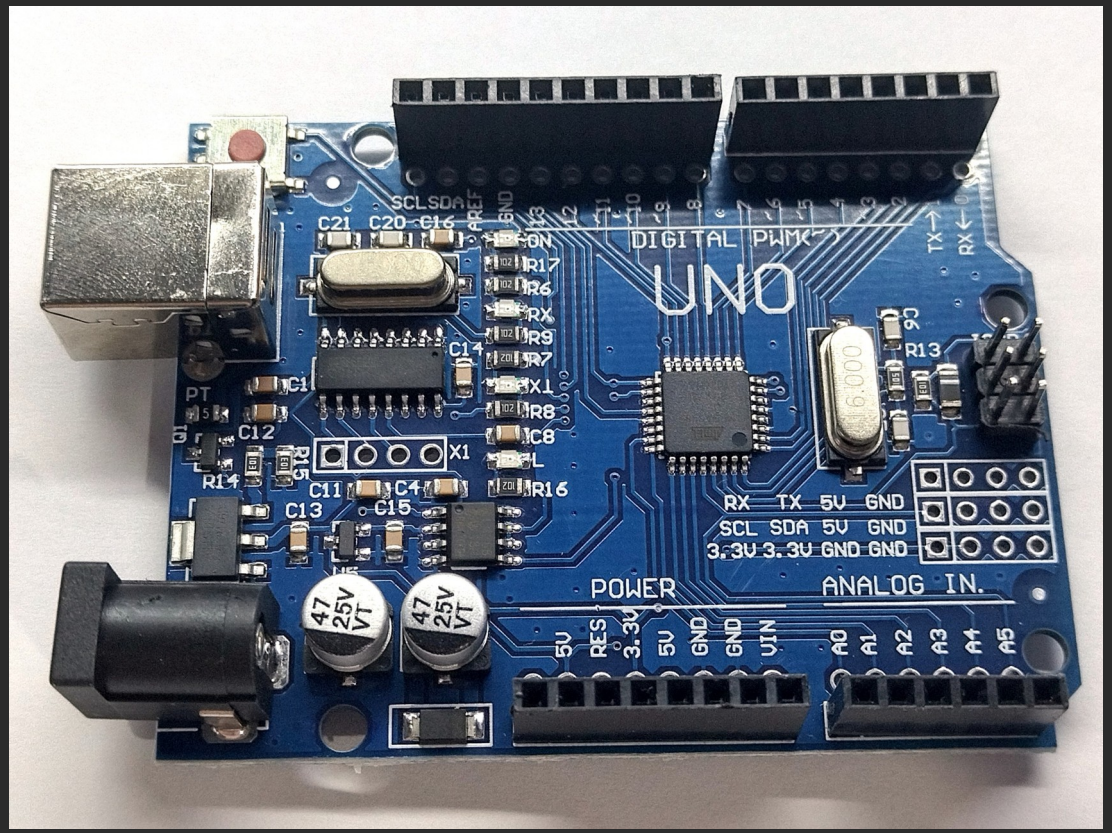
# Flowcharts

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**

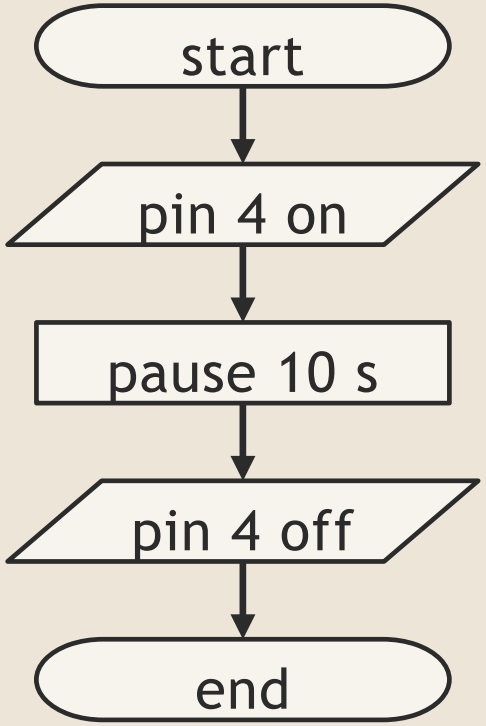
the steps of a program, in order

**Each step**

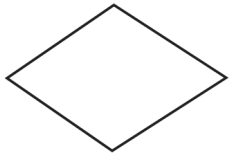
one box

**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**

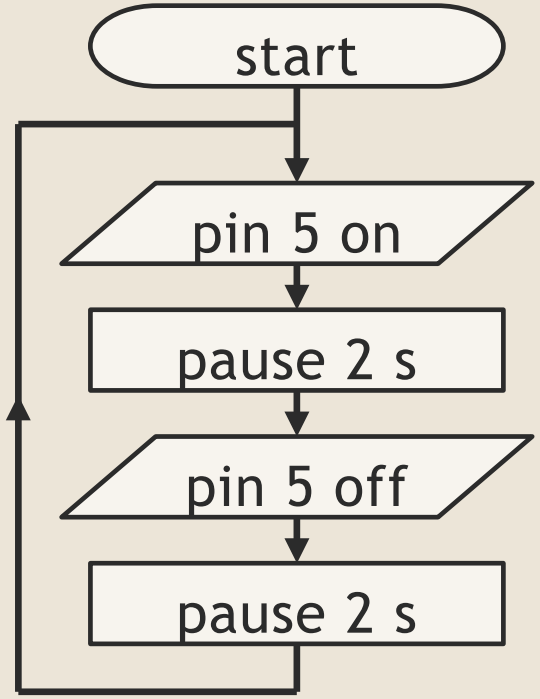
an arrow is not needed

**Up or left**

an arrow is needed

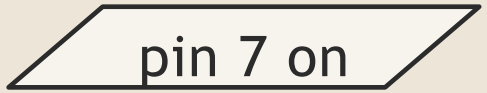
**Every loop back**

give it an arrow: it earns a mark

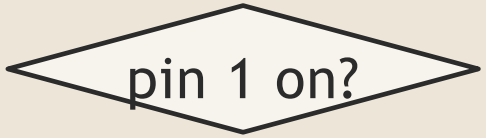


# What Goes in the Box

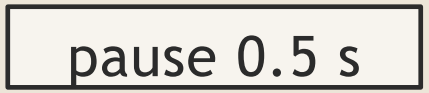
## Output



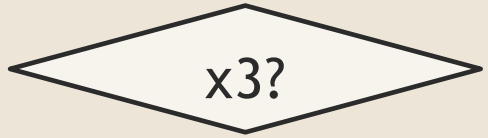

## Input




## 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?

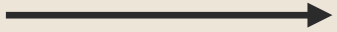
# Name the Symbol

1



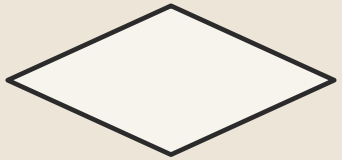
Terminator

2



Line

3



Decision

4



Input or output

5



Process

6



Sub procedure

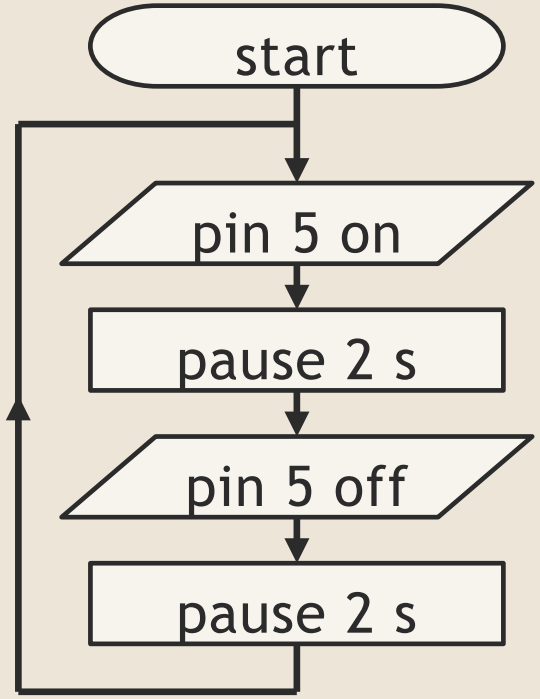
# Continuous Loop

**Repeats**

forever, until the power goes off

**Drawn as**

a line back up, with an arrow



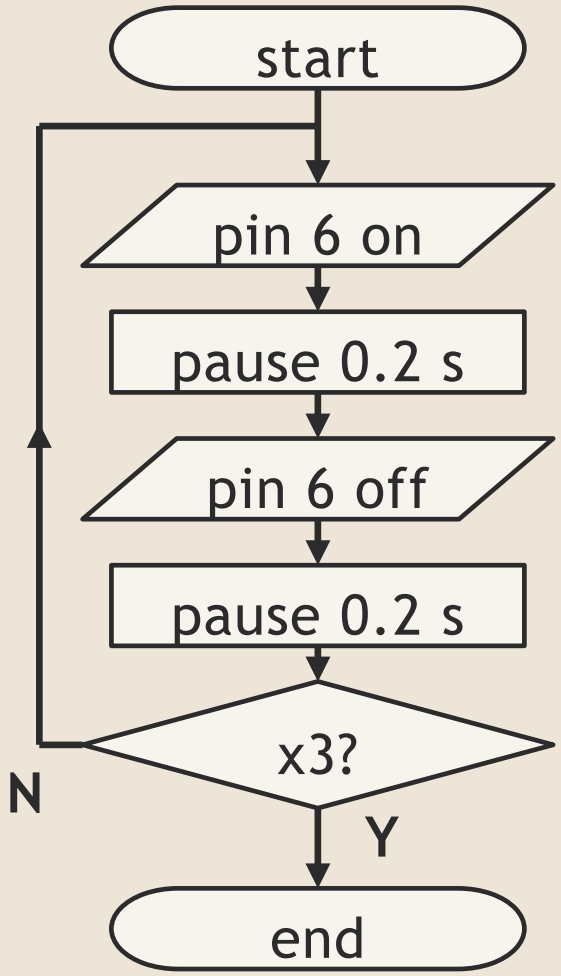
# Fixed Loop

**Repeats**

a set number of times, then moves on

**Drawn as**

a decision, x3?. N goes back up.



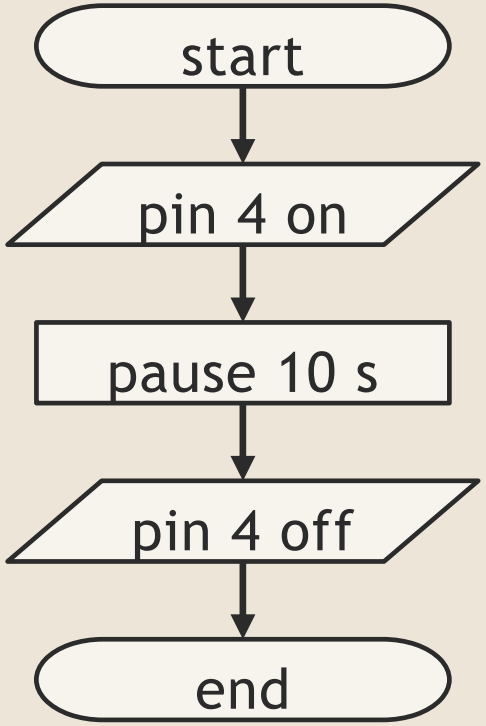
# Time Delay

**A pause**

the program waits for a set time

**Meanwhile**

outputs stay as they are



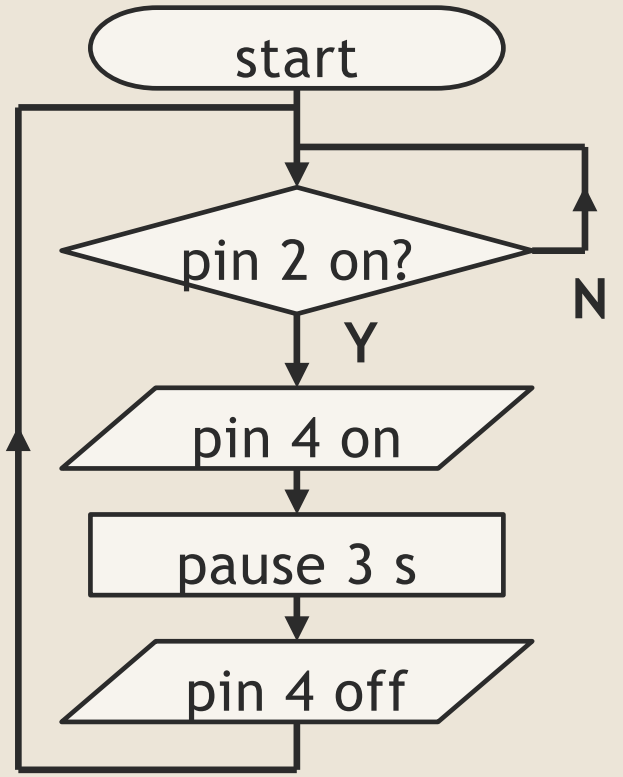
# Branch

**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**.

A time delay

A continuous loop

A fixed loop

# Identify the Programming Structure

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

A branch

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

A branch, in a continuous loop

# 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**.

   The process symbol (a rectangle)

2. **State** which flowchart **lines** need an **arrow**.

   Lines going up or to the left

3. **Explain** why a control program **loops continuously**.

   So it keeps checking its inputs

# Plenary: Part 1

1. **Name** the flowchart symbol shaped like a **diamond**.

The decision symbol

2. **Name** the symbol used for an **input** or an **output**.

The input/output symbol

3. **State** what is meant by a **continuous loop**.

It repeats until the power is removed

# Plenary: Part 1

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

A fixed loop

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

They stay as they are

# 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. | A diamond |
| 2 | **State** the symbol for a **delay**. | The process symbol |
| 3 | **State** what is meant by a **fixed loop**. | It repeats a set number of times |
| 4 | **State** when a line needs an **arrow**. | When it goes up or left |
| 5 | **State** the **two labels** a decision needs. | Y and N |

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 | |

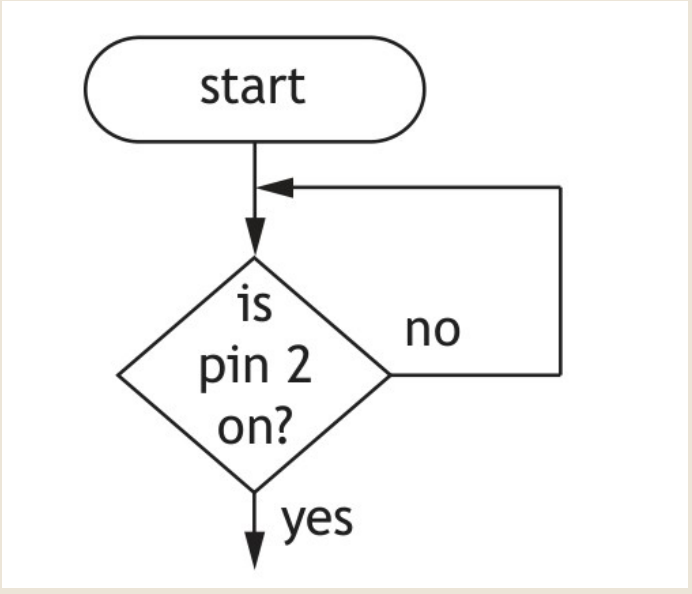
A drying cycle used in the dishwasher operates using the following sequence:

- 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

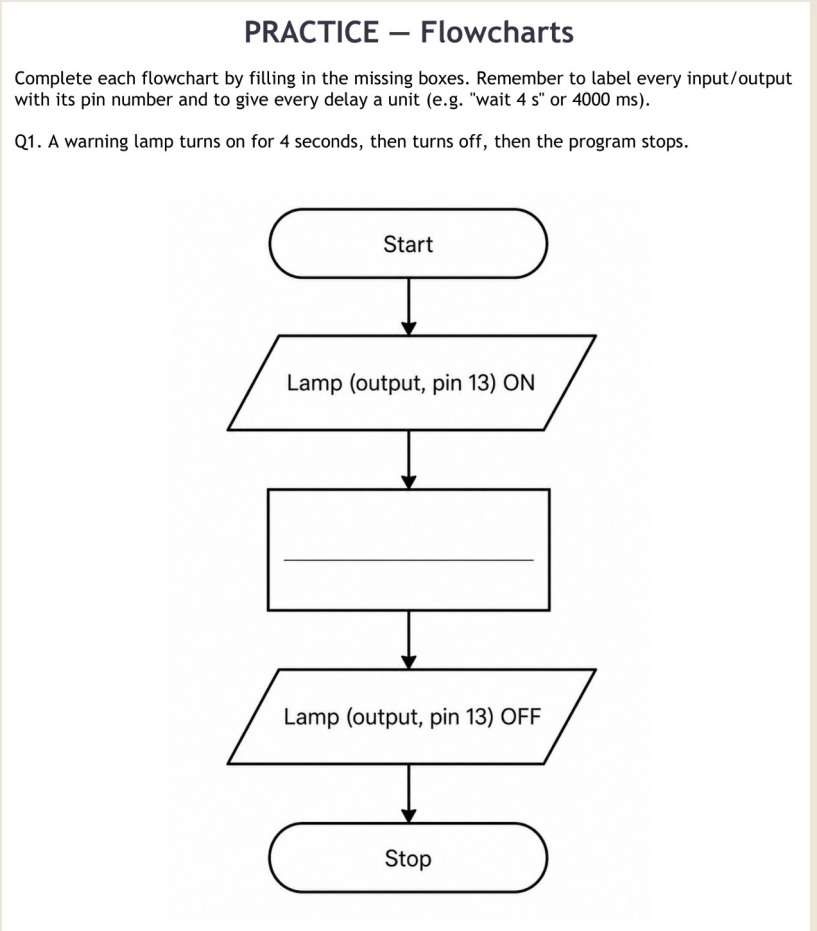
3 The starting point



# 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.**

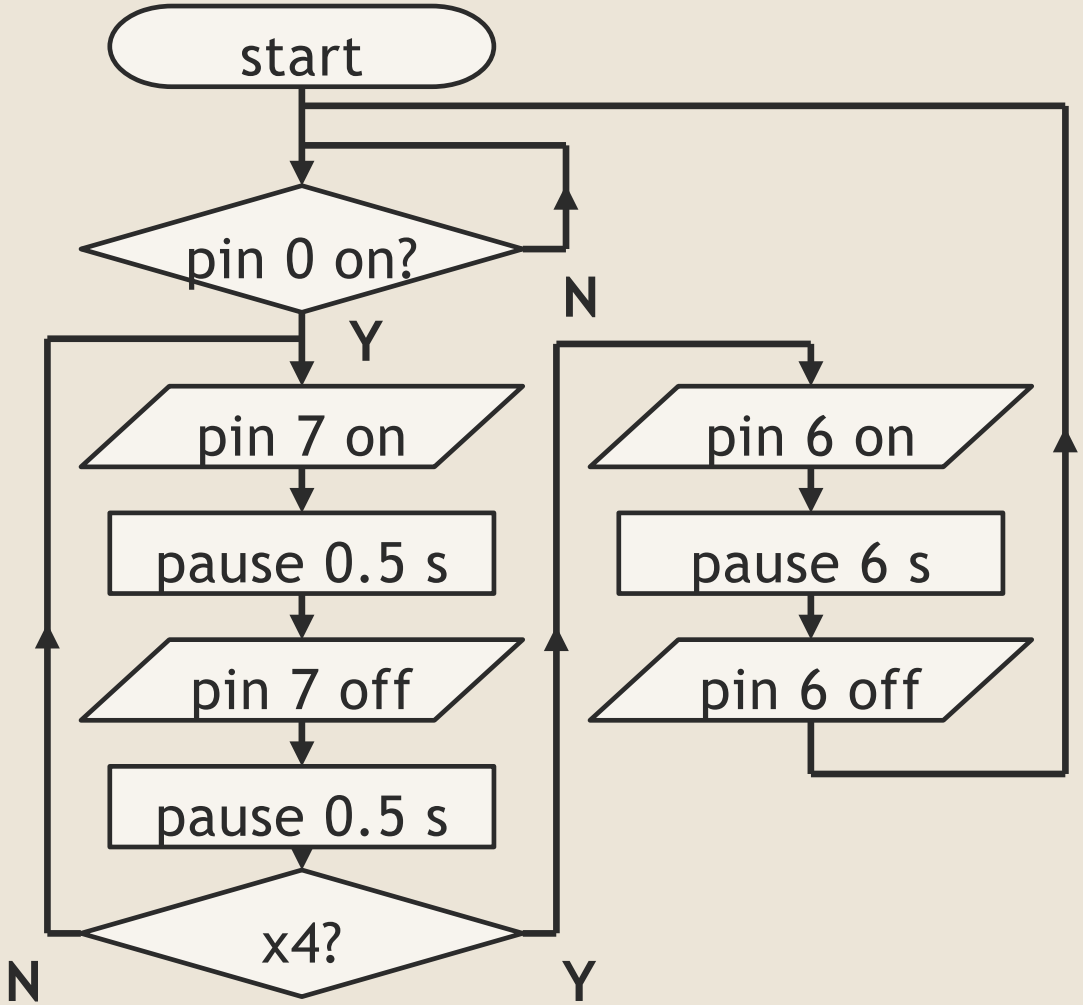
It operates using this sequence:

- 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**.

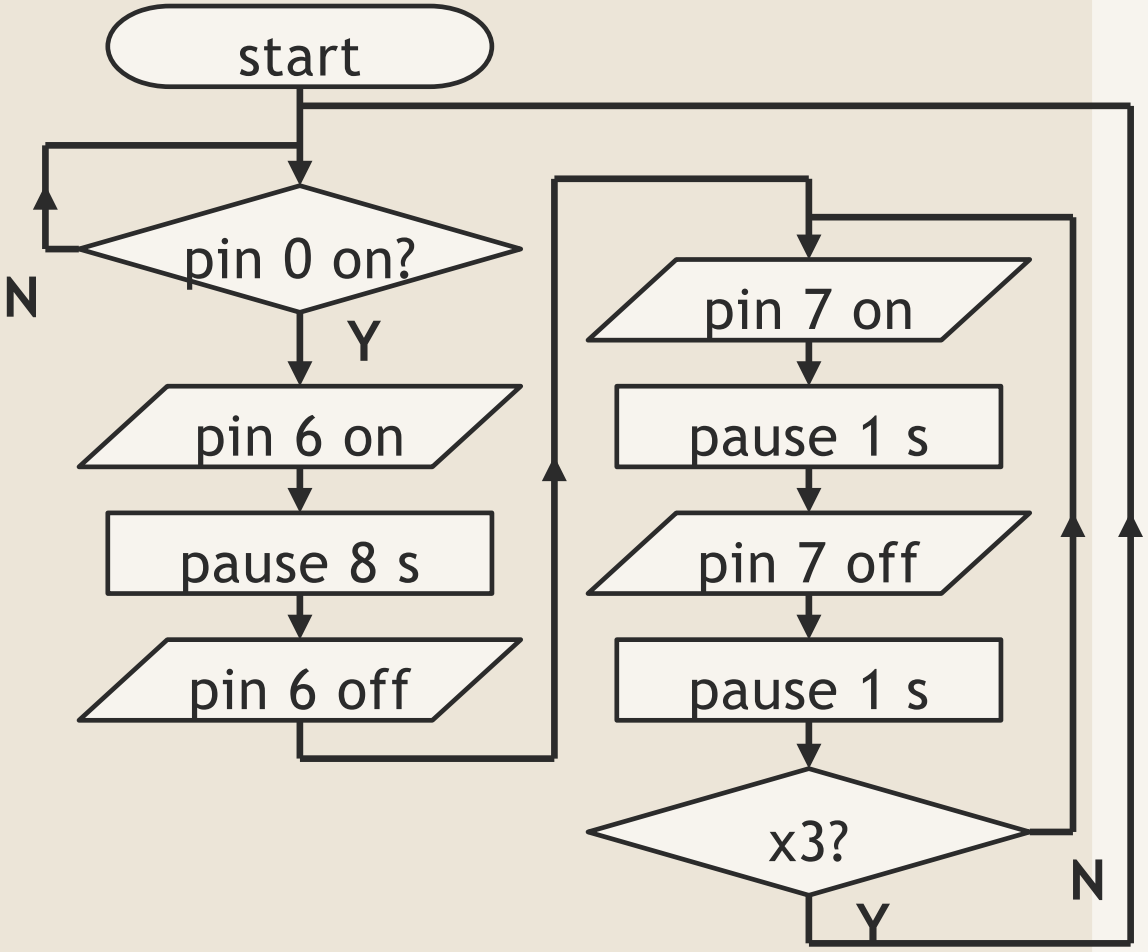
It operates using this sequence:

- 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**.

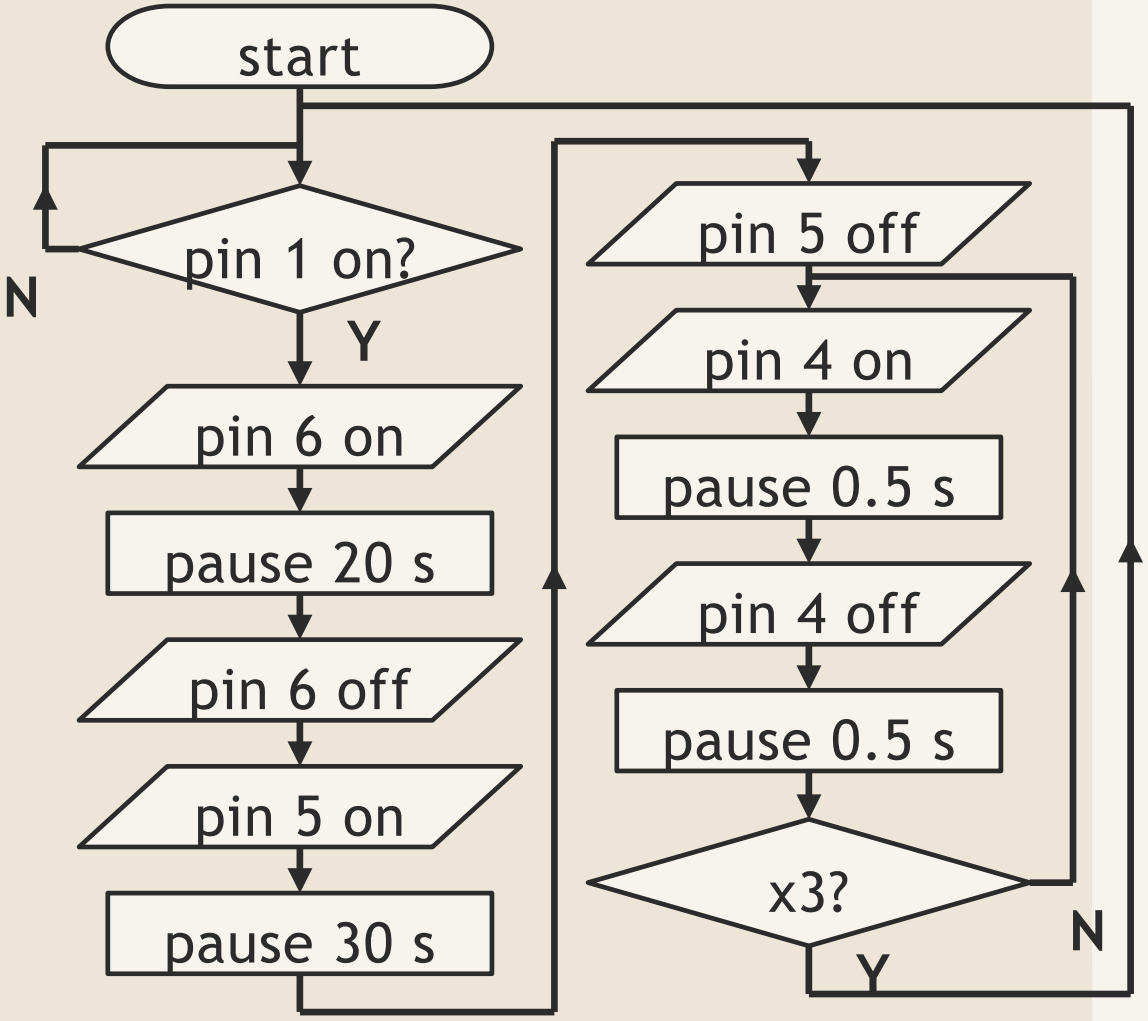
It operates using this sequence:

- 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

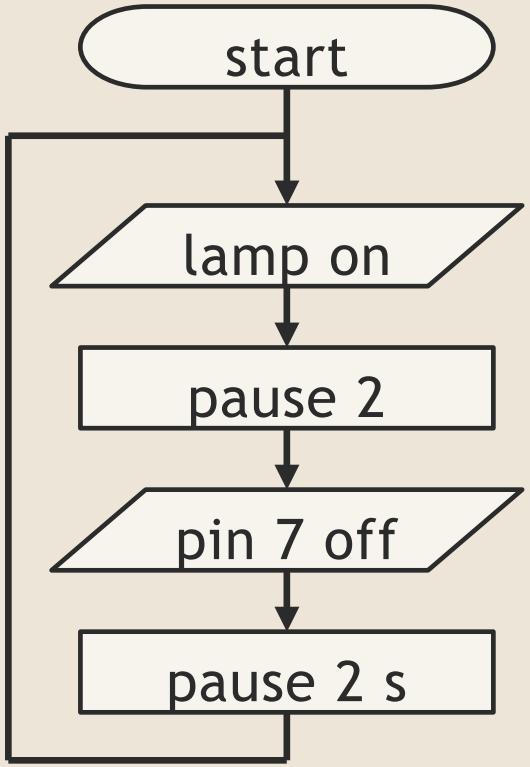


# Spot the Mistake: Three Lost Marks

| 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**.

Its pin number

Its unit, for example s

Lines going up need an arrow

# Plenary: Part 2

1. **Name** the **three things** every exam flowchart question gives.

   A table, a sequence, a starting point

2. A bullet says 'when the switch is pressed'. **Describe** how to **draw** it.

   pin 1 on?, with Y, N and a loop

3. **State** where the **N line** from x3? goes back to.

   To before the steps that repeat

# Plenary: Part 2

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

No: extra steps are ignored

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

An arrow back to start, or an end box

# 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.**

Its pin number

Its unit

An arrow

A fixed loop

A start box

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

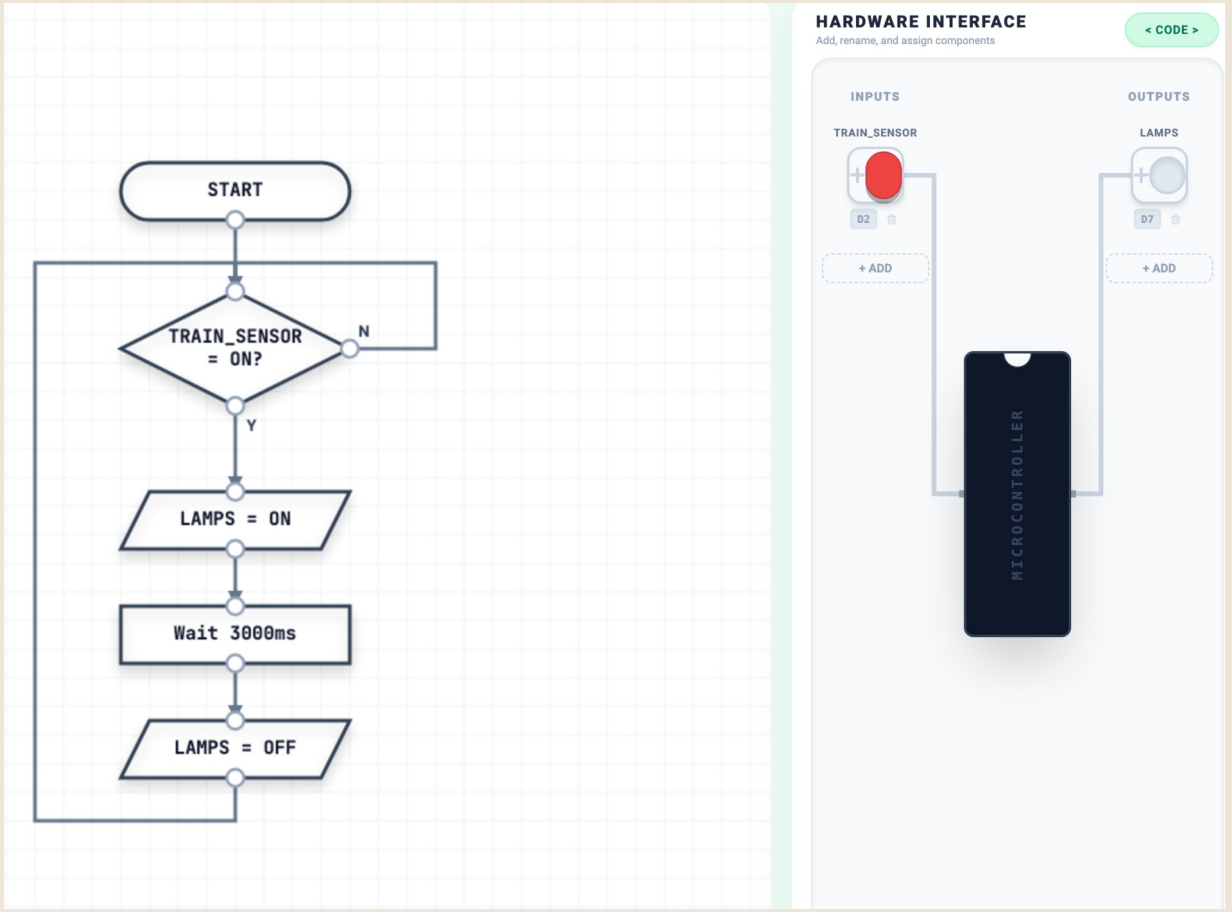
choose its pin

## 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)

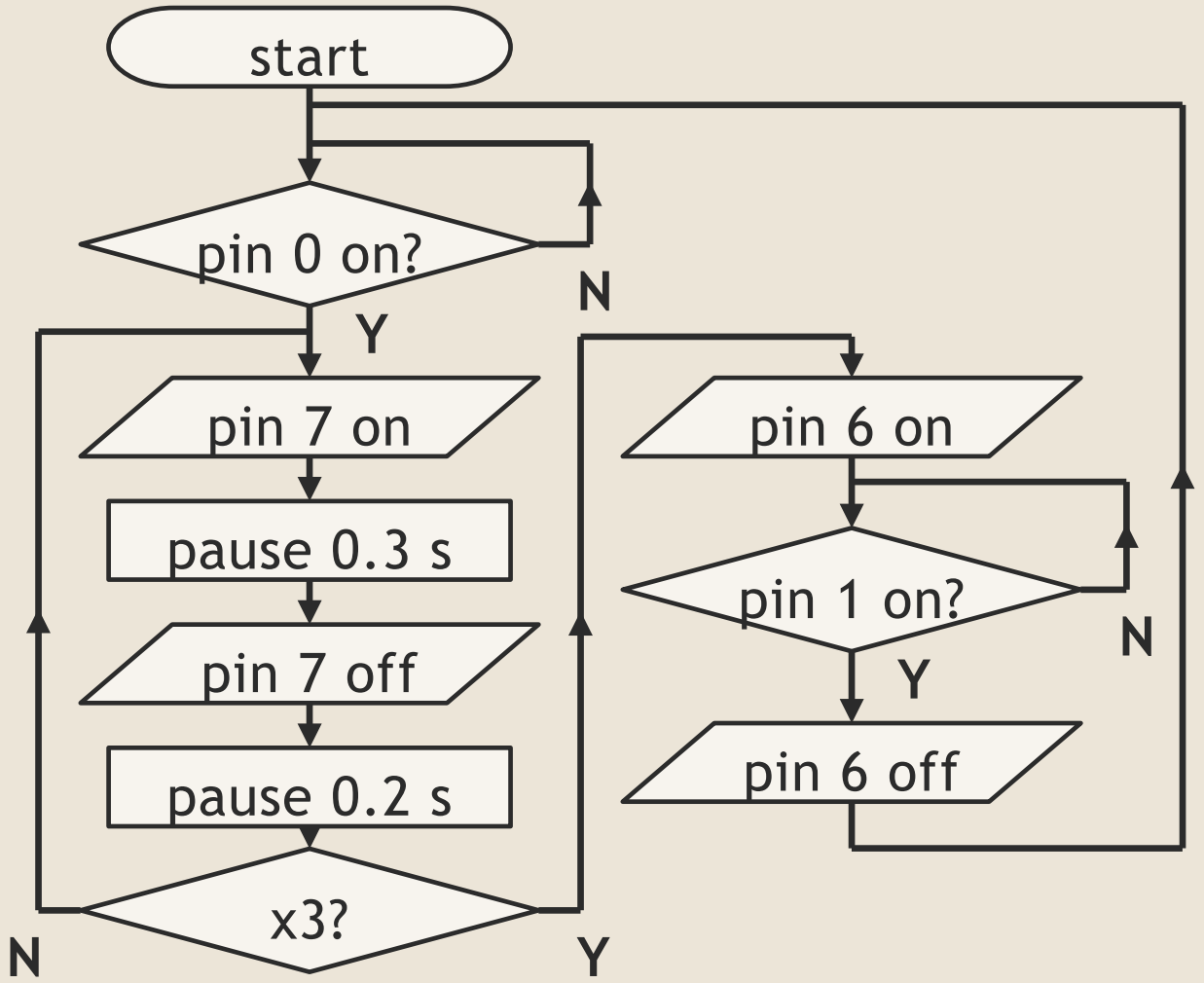
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| | 6 | timer |
| lane switch | 1 | |
| master switch | 0 | |

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)

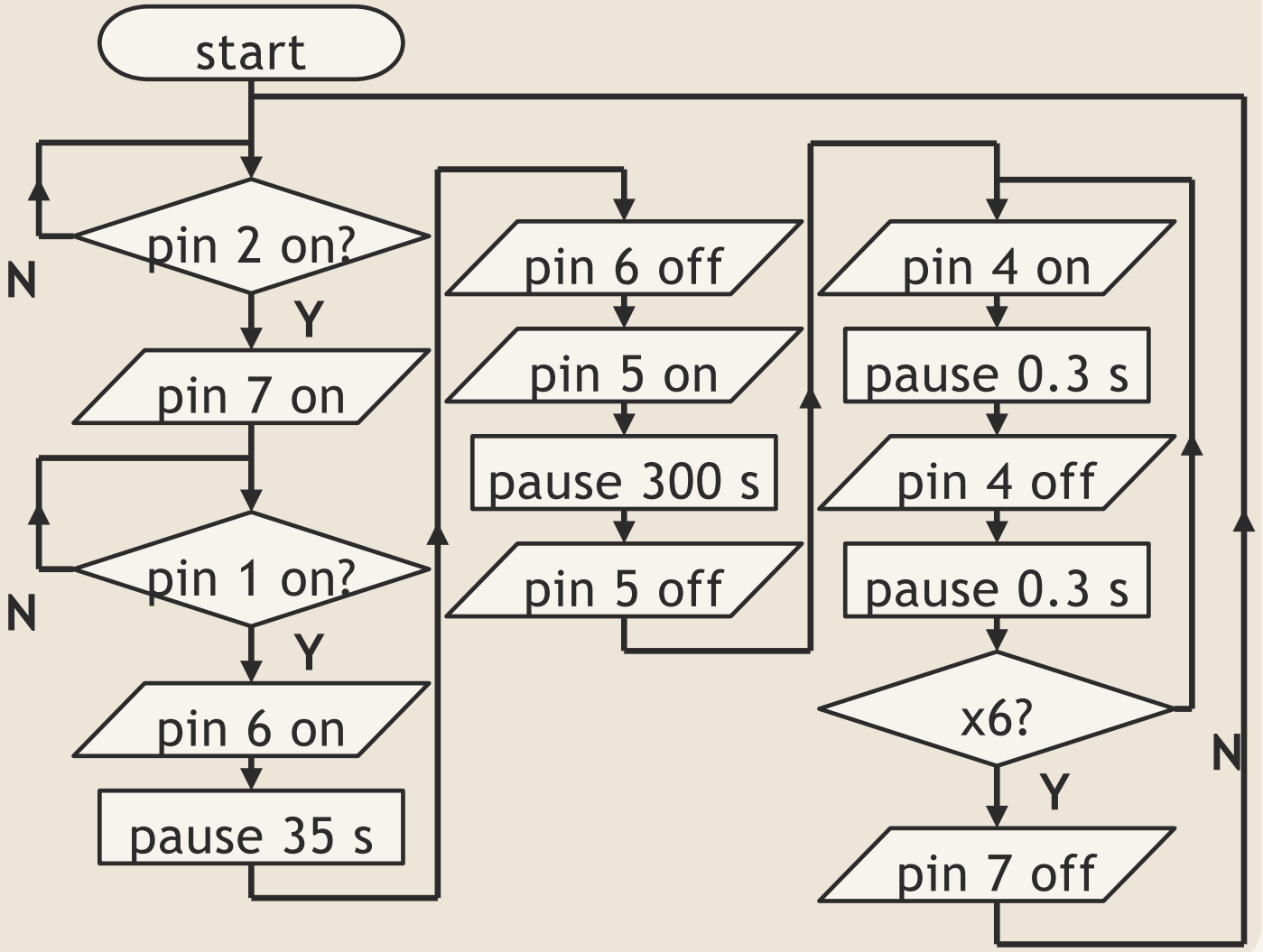
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| Input connection | Pin | Output connection |
|---|---|---|
| | 7 | red LED |
| | 6 | water pump |
| | 5 | heating element |
| | 4 | buzzer |
| | 3 | |
| start switch | 2 | |
| door sensor | 1 | |
| | 0 | |

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.



# 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.

Its pin

Each box lights up as it runs

pause 3 s

# Plenary: Part 3




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

Press the input and watch the output

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

NoSyntaxSim and Yenka

# Extension

EXTRA PRACTICE




1. **Explain** why **x3?** is better than drawing the steps **3 times**.

   Fewer boxes; 3 copies scores 2 marks at most

2. **State** when the **sub-procedure** symbol is used.

   When the program runs a named set of steps

3. Two inputs must **both** be on. **State** how many **decisions** are needed.

   Two, one after the other

# 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