Daily Review



1. **Name** the **diamond** flowchart symbol.
2. **State** the type of loop drawn as **x3?**
3. **State** what a **delay box** must include.
4. **State** which **lines** need an **arrow**.
5. **State** what an **output box** needs.

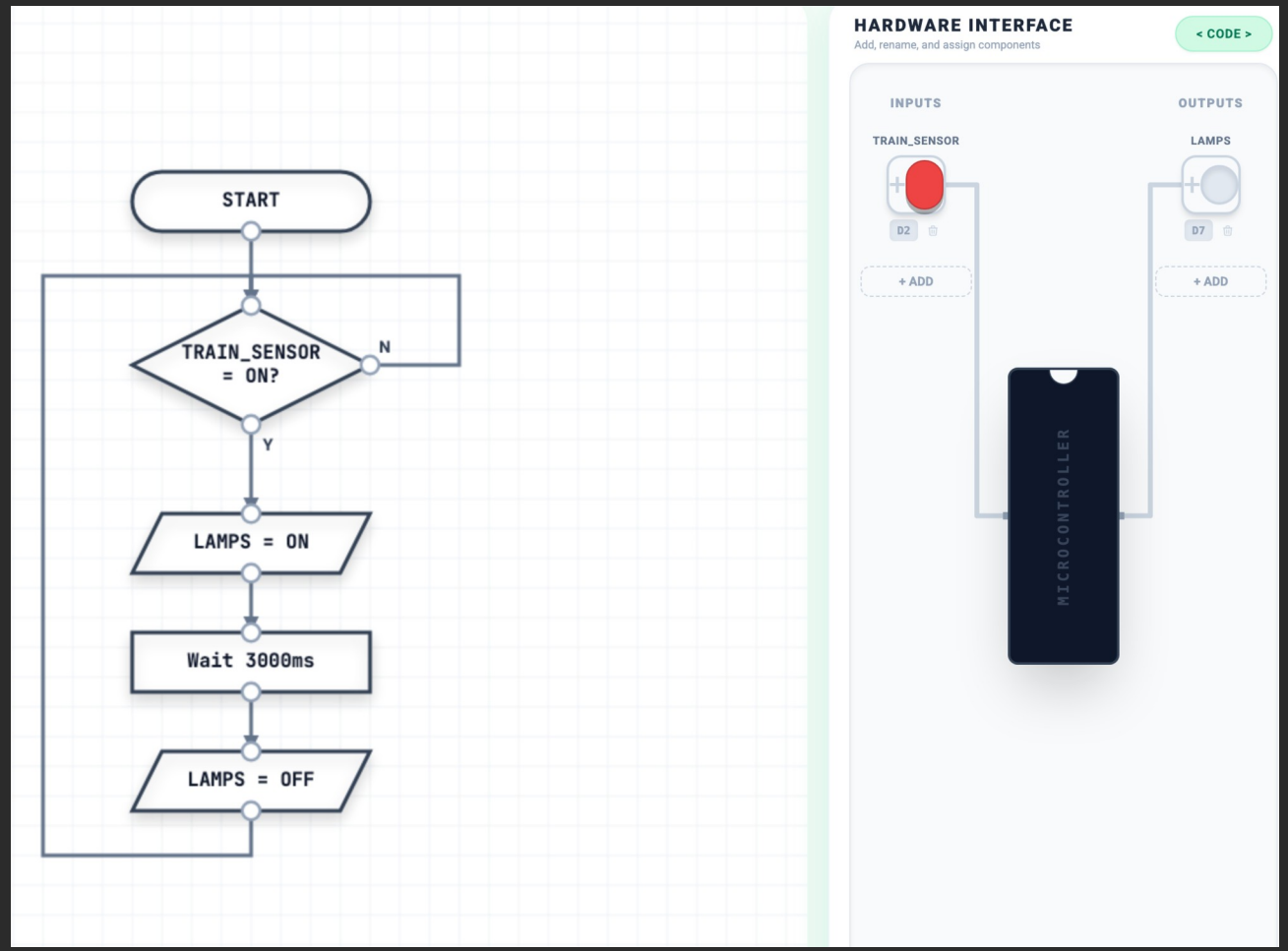
Reading Programs

The exam writes a flowchart as lines. Can you read them?



National 5 Engineering Science

Here is the flowchart. Written as lines, which line is the delay?



PART 1

Reading the Exam's Program

Line by line, box by box.

By the end of this part…



1. I can **state** what each **line** of an exam **program** does
2. I can **find** the **line number** that does a job
3. I can **state** how many times a **counter loop** runs

The Words the Exam Uses



switch on 7

pin 7 on

pause 500

wait 500 ms = 0.5 s

main: label_1:

a name for a line

goto main

jump to that line

if … then label_1

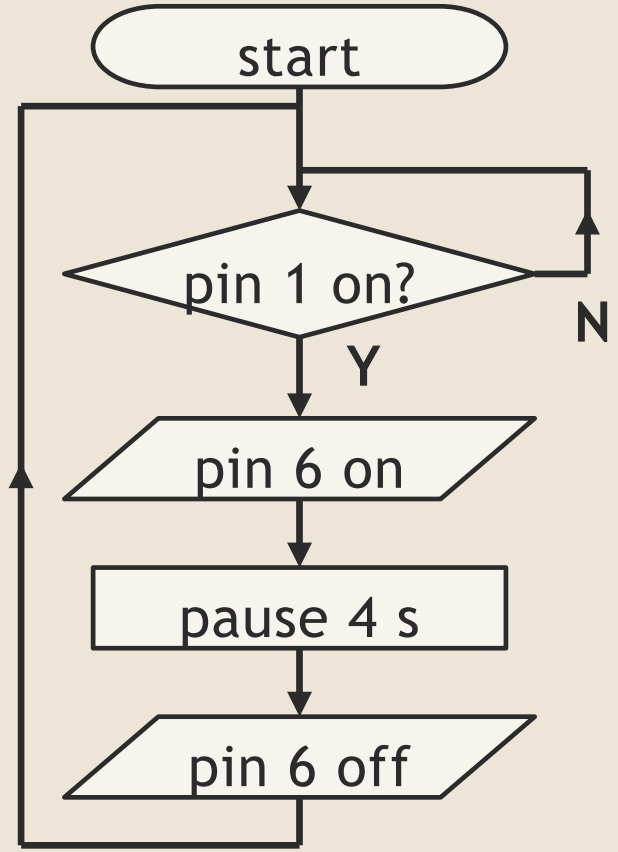
a decision

let count = …

a counter

One Program, One Flowchart

```
1    main:      if input1 is off then main
2               switch on 6
3               pause 4000
4               switch off 6
5               goto main
```



One Program, Both Ways

PSEUDOCODE

Flowchart

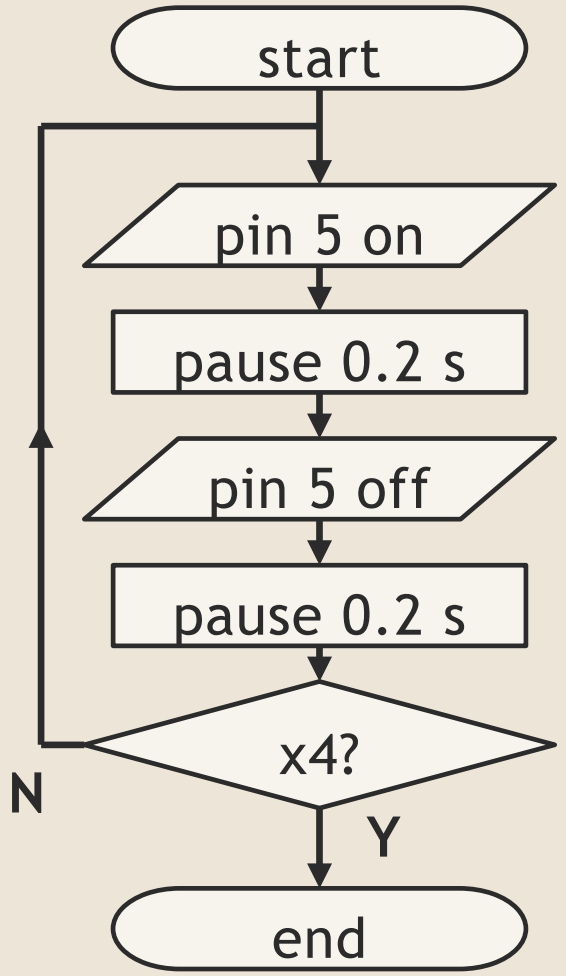
```
1 main:   if input1 is off then main
2         switch on 6
3         pause 4000
4         switch off 6
5         goto main
```

ARDUINO C++

```
1  void setup() {
2    pinMode(1, INPUT);
3    pinMode(6, OUTPUT);
4  }
5  void loop() {
6    while (digitalRead(1) == LOW) { }
7    digitalWrite(6, HIGH);
8    delay(4000);
9    digitalWrite(6, LOW);
10 }
```

Counting: The Fixed Loop in Code

```
1   main:       let count = 0
2   label_1:    switch on 5
3               pause 200
4               switch off 5
5               pause 200
6               let count = count + 1
7               if count = 4 then label_2
8               goto label_1
9   label_2:    end
```



Counting, Both Ways

PSEUDOCODE

Flowchart

```
1 main:     let count = 0
2 label_1:  switch on 5
3           pause 200
4           switch off 5
5           pause 200
6           let count = count + 1
7           if count = 4 then label_2
8           goto label_1
9 label_2:  end
```

ARDUINO C++

```
1  void setup() {
2    pinMode(5, OUTPUT);
3  }
4  void loop() {
5    for (int count = 0; count < 4; count++) {
6      digitalWrite(5, HIGH);
7      delay(200);
8      digitalWrite(5, LOW);
9      delay(200);
10   }
11   while (true) { }
12 }
```

Read It (3 marks)

A microcontroller program is shown.

```
1   main:       if input2 is off then main
2               let count = 0
3   label_1:    switch on 7
4               pause 1500
5               switch off 7
6               let count = count + 1
7               if count = 8 then label_2
8               goto label_1
9   label_2:    pause 2500
10              goto main
```

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

(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)

Read It: The Answers



```
1   main:     if input2 is off then main
2             let count = 0
3   label_1:  switch on 7
4             pause 1500
5             switch off 7
6             let count = count + 1
7             if count = 8 then label_2
8             goto label_1
9   label_2:  pause 2500
10            goto main
```

(a) A line with a **time delay**

(b) Times **pin 7** turns on and off

(c) The **type of loop**

Read It, Both Ways

PSEUDOCODE

Flowchart

```
1   main:     if input2 is off then main
2             let count = 0
3   label_1:  switch on 7
4             pause 1500
5             switch off 7
6             let count = count + 1
7             if count = 8 then label_2
8             goto label_1
9   label_2:  pause 2500
10            goto main
```

ARDUINO C++

```
1   void setup() {
2     pinMode(2, INPUT);
3     pinMode(7, OUTPUT);
4   }
5   void loop() {
6     while (digitalRead(2) == LOW) { }
7     for (int count = 0; count < 8; count++) {
8       digitalWrite(7, HIGH);
9       delay(1500);
10      digitalWrite(7, LOW);
11    }
12    delay(2500);
13  }
```

Exam Style: The Function of a Line (1 mark)

A microcontroller program is shown.

```
1    main:     if input1 is off then main
2              switch on 6
3              pause 4000
4              switch off 6
5              goto main
```

Describe the **function** of **line 5** in the program. (1)

Model Answer: The Function of a Line

```
1    main:    if input1 is off then main
2             switch on 6
3             pause 4000
4             switch off 6
5             goto main
```

Describe the **function** of **line 5.**

Checkpoint



1. **State** how long **pause 750** waits. (**value and unit**)
2. **State** the type of **loop** that **goto main** makes.
3. **Explain** why a program needs a **label**.

Plenary: Part 1



1. **State** what **switch off 4** does.
2. **State** the **unit** of the number after **pause**.
3. **Name** the flowchart **symbol** for **if count = 5 then label_2**.

Plenary: Part 1



4 **State** what **let count = count + 1** does.

5 **State** the **marks** for **'it goes to main'** on its own.

Look back — by the end of this part…



1. I can **state** what each **line** of an exam **program** does
2. I can **find** the **line number** that does a job
3. I can **state** how many times a **counter loop** runs

Daily Review



1. **State** how long **pause 1500** waits. (**value and unit**)
2. **State** where **goto label_1** jumps to.
3. **State** the **value** of **count** after **let count = 0**.
4. **Name** the **command** for a **time delay**.
5. **State** the **marks** for **'goes to main'** alone.

PART 2

When It Goes Wrong

It should beep 10 times. It never stops. Why?

By the end of this part…



1. I can **trace** a **counter loop**, pass by pass
2. I can **explain** why a program does **not repeat**
3. I can **write** a **flowchart** as a **program**

Trace It, Pass by Pass

```
1   main:       let count = 0
2   label_1:    switch on 4
3               let count = count + 1
4               switch off 4
5               if count = 3 then label_2
6               goto label_1
7   label_2:    end
```

State the **number of times** that **pin 4** will turn on and then off.

Run count = 3? line

Trace It, Both Ways

PSEUDOCODE

Flowchart

```
1 main:     let count = 0
2 label_1:  switch on 4
3           let count = count + 1
4           switch off 4
5           if count = 3 then label_2
6           goto label_1
7 label_2:  end
```

ARDUINO C++

```
1  void setup() {
2    pinMode(4, OUTPUT);
3  }
4  void loop() {
5    for (int count = 0; count < 3; count++) {
6      digitalWrite(4, HIGH);
7      digitalWrite(4, LOW);
8    }
9    while (true) { }
10 }
```

Exam Style: Why It Does Not Repeat (2 marks)

A microcontroller program is shown.

```
1    main:       let count = 0
2    label_1:    switch on 7
3                pause 300
4                switch off 7
5                pause 300
6                let count = count + 1
7                if count = 10 then label_2
8                goto main
9    label_2:    switch on 5
10               end
```

Lines 2 to **7** should repeat **ten times** before moving on to **line 9**. During testing, an engineer found that this did not happen.

Explain why **lines 2** to **7** did not repeat ten times before moving on to **line 9**. (2)

Model Answer: Why It Does Not Repeat



```
1   main:       let count = 0
2   label_1:    switch on 7
3               pause 300
4               switch off 7
5               pause 300
6               let count = count + 1
7               if count = 10 then label_2
8               goto main
9   label_2:    switch on 5
10              end
```

Explain why **lines 2** to **7** did not repeat.

Watch Out: Loop Back Below the Count

THE MISTAKE

- 8 goto main
- The count goes back to 0.
- It never reaches 10.

THE CORRECT ANSWER

- 8 goto label_1
- The count keeps going up.
- It stops at 10.

The Fixed Program, Both Ways

PSEUDOCODE

Flowchart

```
1   main:     let count = 0
2   label_1:  switch on 7
3             pause 300
4             switch off 7
5             pause 300
6             let count = count + 1
7             if count = 10 then label_2
8             goto label_1
9   label_2:  switch on 5
10            end
```

ARDUINO C++

```
1   void setup() {
2     pinMode(5, OUTPUT);
3     pinMode(7, OUTPUT);
4   }
5   void loop() {
6     for (int count = 0; count < 10; count++) {
7       digitalWrite(7, HIGH);
8       delay(300);
9       digitalWrite(7, LOW);
10      delay(300);
11    }
12    digitalWrite(5, HIGH);
13    while (true) { }
14  }
```

Spot the Mistake



```
1   main:       let count = 0
2   label_1:    switch on 6
3               pause 500
4               switch off 6
5               pause 500
6               if count = 3 then label_2
7               goto label_1
8   label_2:    switch on 7
9               end
```

Lines 2 to **5** should repeat **three times** before moving on to **line 8**.

During testing, pin 6 flashed **for ever**.

Explain why the program **never** moves on to **line 8**.

Spot the Mistake: Fixed, Both Ways

PSEUDOCODE

Flowchart

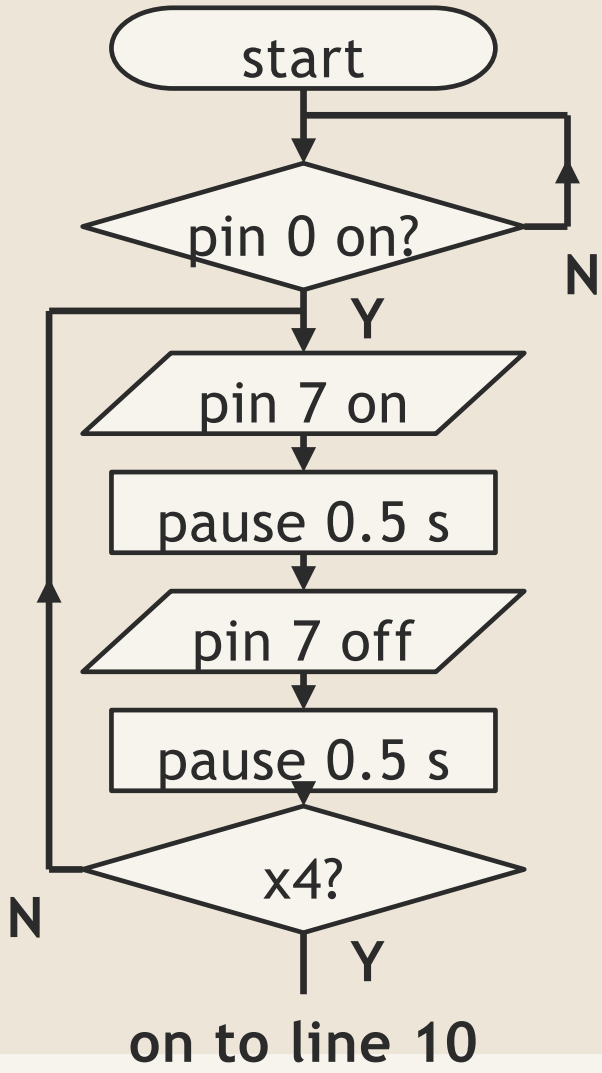
```
1   main:     let count = 0
2   label_1:  switch on 6
3             pause 500
4             switch off 6
5             pause 500
6             let count = count + 1
7             if count = 3 then label_2
8             goto label_1
9   label_2:  switch on 7
10            end
```

ARDUINO C++

```
1   void setup() {
2     pinMode(6, OUTPUT);
3     pinMode(7, OUTPUT);
4   }
5   void loop() {
6     for (int count = 0; count < 3; count++) {
7       digitalWrite(6, HIGH);
8       delay(500);
9       digitalWrite(6, LOW);
10      delay(500);
11    }
12    digitalWrite(7, HIGH);
13    while (true) { }
14  }
```

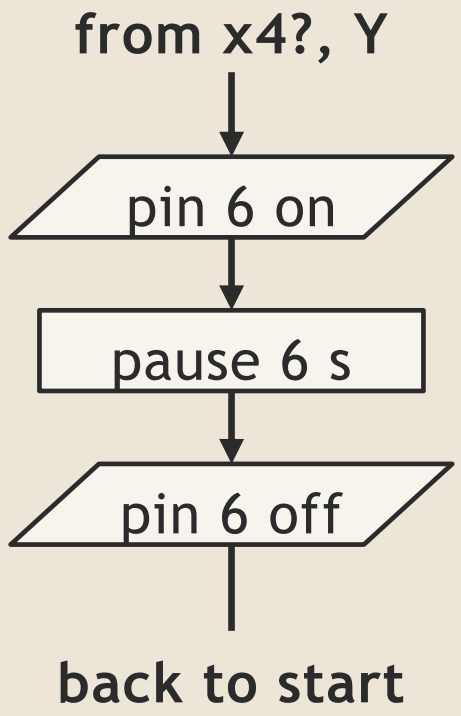
Flowchart to Program (1 of 2)

```
1   main:       if input0 is off then main
2               let count = 0
3   label_1:    switch on 7
4               pause 500
5               switch off 7
6               pause 500
7               let count = count + 1
8               if count = 4 then label_2
9               goto label_1
```



Flowchart to Program (2 of 2)

```
10  label_2:    switch on 6
11               pause 6000
12               switch off 6
13               goto main
```



The Level Crossing, Both Ways

PSEUDOCODE

Flowchart

```
1   main:       if input0 is off then main
2               let count = 0
3   label_1:    switch on 7
4               pause 500
5               switch off 7
6               pause 500
7               let count = count + 1
8               if count = 4 then label_2
9               goto label_1
10  label_2:    switch on 6
11              pause 6000
12              switch off 6
13              goto main
```

ARDUINO C++

```
1   void setup() {
2     pinMode(0, INPUT);
3     pinMode(6, OUTPUT);
4     pinMode(7, OUTPUT);
5   }
6   void loop() {
7     while (digitalRead(0) == LOW) { }
8     for (int count = 0; count < 4; count++) {
9       digitalWrite(7, HIGH);
10      delay(500);
11      digitalWrite(7, LOW);
12      delay(500);
13    }
14    digitalWrite(6, HIGH);
15    delay(6000);
16    digitalWrite(6, LOW);
17  }
```

Your Turn: Draw the Flowchart

A microcontroller program is shown.

```
1    main:     if input3 is off then main
2              switch on 5
3              switch on 4
4              pause 2000
5              switch off 5
6              pause 1000
7              switch off 4
8              goto main
```

Draw the **flowchart** for this program.

Include all pin numbers and **delay units**.

Your Turn: The Flowchart



```
1   main:     if input3 is off then main
2             switch on 5
3             switch on 4
4             pause 2000
5             switch off 5
6             pause 1000
7             switch off 4
8             goto main
```



Your Turn: Both Ways

PSEUDOCODE

Flowchart

```
1  main:   if input3 is off then main
2          switch on 5
3          switch on 4
4          pause 2000
5          switch off 5
6          pause 1000
7          switch off 4
8          goto main
```

ARDUINO C++

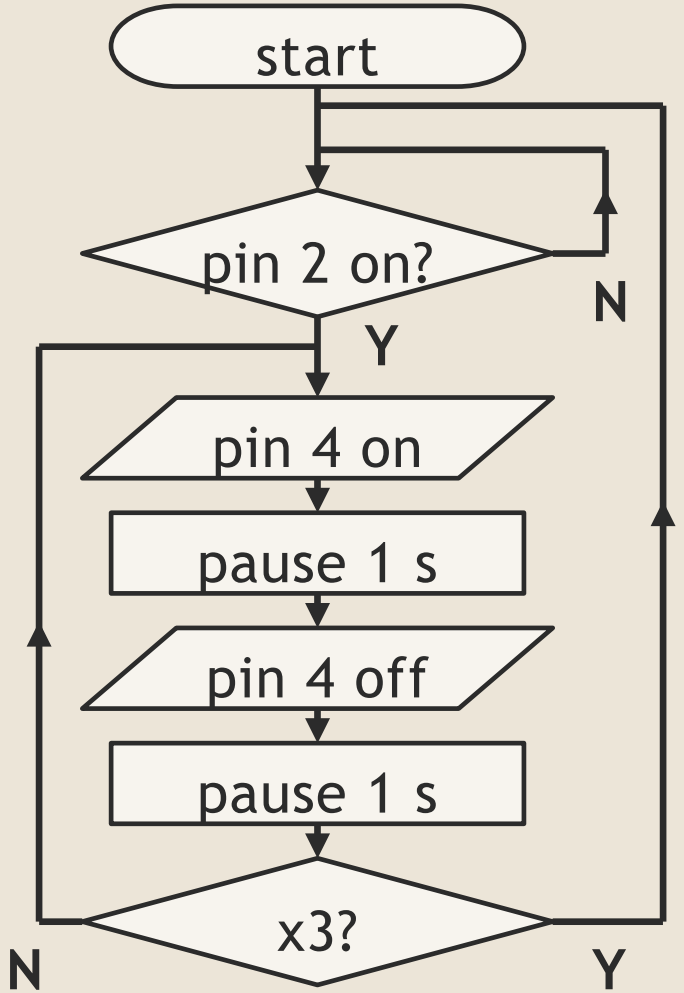
```
1   void setup() {
2     pinMode(3, INPUT);
3     pinMode(4, OUTPUT);
4     pinMode(5, OUTPUT);
5   }
6   void loop() {
7     while (digitalRead(3) == LOW) { }
8     digitalWrite(5, HIGH);
9     digitalWrite(4, HIGH);
10    delay(2000);
11    digitalWrite(5, LOW);
12    delay(1000);
13    digitalWrite(4, LOW);
14  }
```

Your Turn: Flowchart to Program

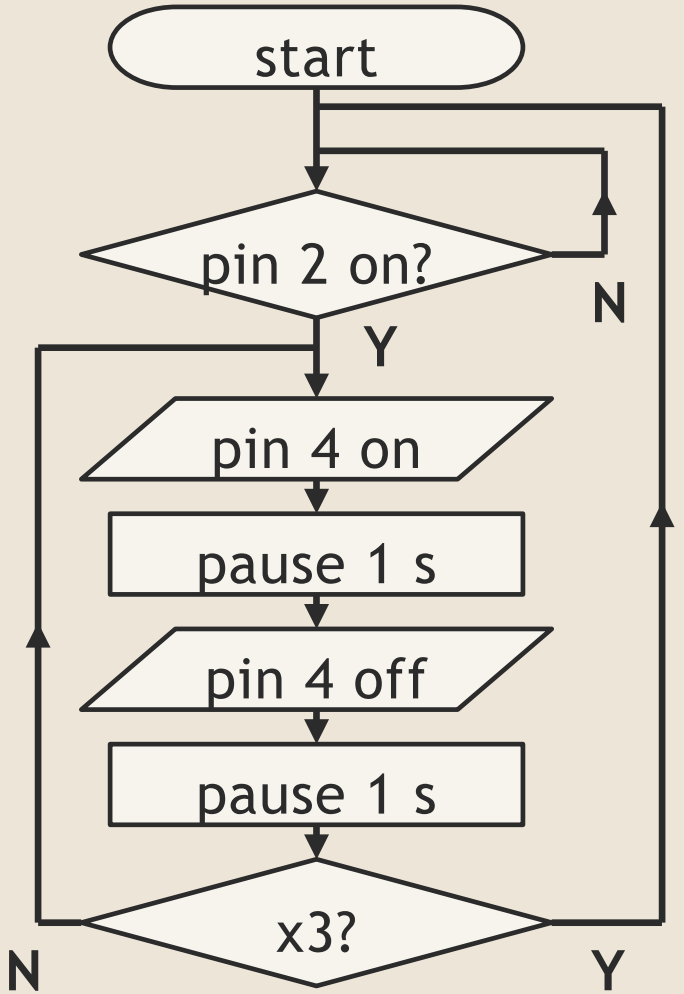
Write the **program** for this flowchart, in the exam's form.

Use **one line** for each **box**.

Check the **labels**, the **times in ms** and the **goto** lines.



Your Turn: The Program



Your Program, Both Ways

PSEUDOCODE

Flowchart

```
1  main:     if input2 is off then main
2            let count = 0
3  label_1:  switch on 4
4            pause 1000
5            switch off 4
6            pause 1000
7            let count = count + 1
8            if count = 3 then main
9            goto label_1
```

ARDUINO C++

```
1   void setup() {
2     pinMode(2, INPUT);
3     pinMode(4, OUTPUT);
4   }
5   void loop() {
6     while (digitalRead(2) == LOW) { }
7     for (int count = 0; count < 3; count++) {
8       digitalWrite(4, HIGH);
9       delay(1000);
10      digitalWrite(4, LOW);
11      delay(1000);
12    }
13  }
```

Past Papers: Reading Programs

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.

_____

2023 Q9(c)

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.

Line number _____

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

_____

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

2025 Q2

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.

_____

_____

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**.

2022 Q9(b)(c)

Answers: Past Papers

Question	Answer
2023 Q9(c) **State**	Line 7 (the time delay)
2025 Q2(a) **State**	Line 5 or line 7 (a time delay)
2025 Q2(b) **State**	15 times
2025 Q2(c) **State**	A fixed (finite) loop
2022 Q9(b) **Describe**	It goes back to line 1, so it repeats forever.
2022 Q9(c) **Explain**	Line 10 goes back to line 1, so the count resets to 0.

Past Papers: Find Them All

Past papers

Year	Question
2022	Q9(b), (c)
2023	Q9(c)
2025	Q2

By topic

Checkpoint



1. A count never reaches its limit. **State** the **line** to **look for**.
2. A program has no **let** **count = count + 1** line. **Describe** what **happens**.
3. **Explain** why the loop must go back to **label_1**, not **main**.

Plenary: Part 2

1. **State** the **two parts** of a 2-mark **explain** answer.
2. **State** the **word** that joins the cause and the effect.
3. **State** the **three lines** that **x4?** becomes.

Plenary: Part 2



4 **State** the **line** that the **arrow back up** becomes.

5 Line 1 is **if input1 is off then main**. **State** where its **N loop** goes.

Look back — by the end of this part…



1. I can **trace** a **counter loop**, pass by pass
2. I can **explain** why a program does **not repeat**
3. I can **write** a **flowchart** as a **program**

LOOKING AHEAD

Lesson 3b: Writing Arduino C++

Write it so the Uno can run it.

Course Specification

Digital electronic control systems

- using suitable commands (high, low, for…next, if…then, pause, end (or their equivalents)) to design programs to solve simple control problems, involving time delays and continuous and fixed loops

Credits (1 of 2)

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

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

Model Answer: The Function of a Line (2022 Q9(b) MI): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2022 Q9(b)(c), 2023 Q9(c), 2025 Q2.

Model Answer: Why It Does Not Repeat (2022 Q9(c) MI): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2022 Q9(b)(c), 2023 Q9(c), 2025 Q2.

Watch Out (2022 Q9(c) MI): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2022 Q9(b)(c), 2023 Q9(c), 2025 Q2.

Credits (2 of 2)

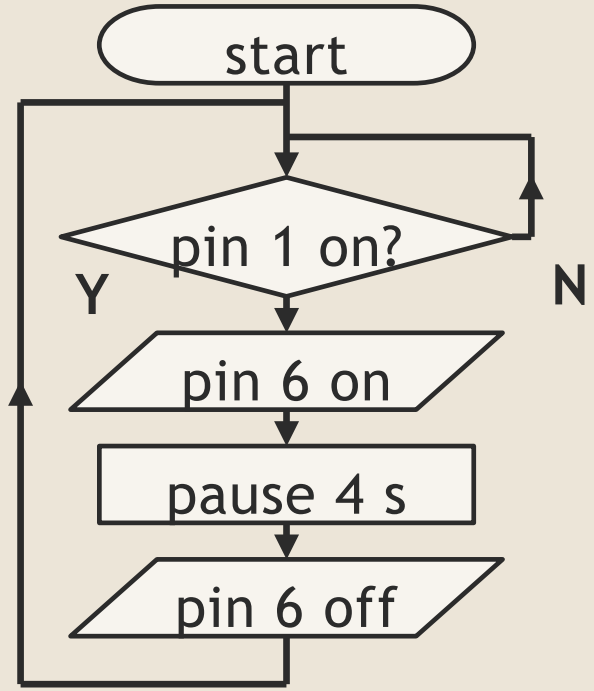
Past Papers: Reading Programs: © Qualifications Scotland (SQA). N5 Engineering Science 2022 Q9(b)(c), 2023 Q9(c) and 2025 Q2, question papers and marking instructions.

Answers: Past Papers (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2022 Q9(b)(c), 2023 Q9(c), 2025 Q2.

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

R Stewart - October 2026

The Flowchart: One Program

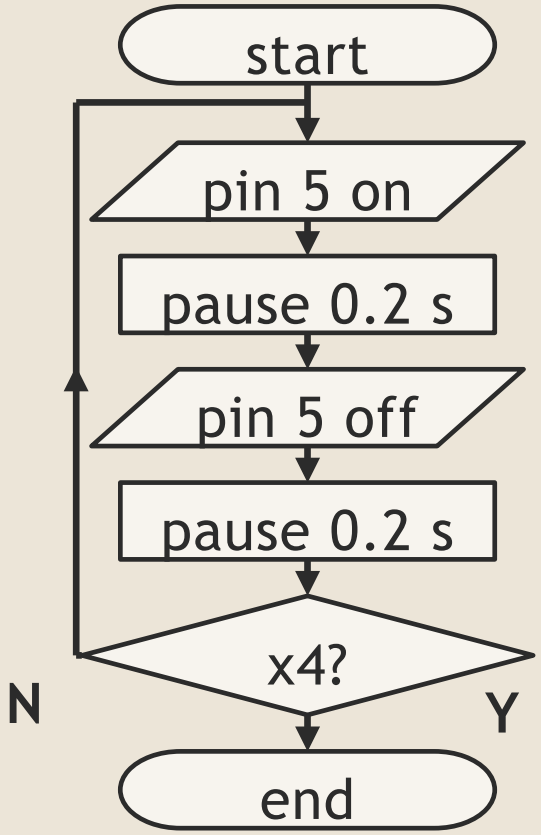


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(1, INPUT);
3    pinMode(6, OUTPUT);
4  }
5  void loop() {
6    while (digitalRead(1) == LOW) { }
7    digitalWrite(6, HIGH);
8    delay(4000);
9    digitalWrite(6, LOW);
10 }
```

The Flowchart: Counting

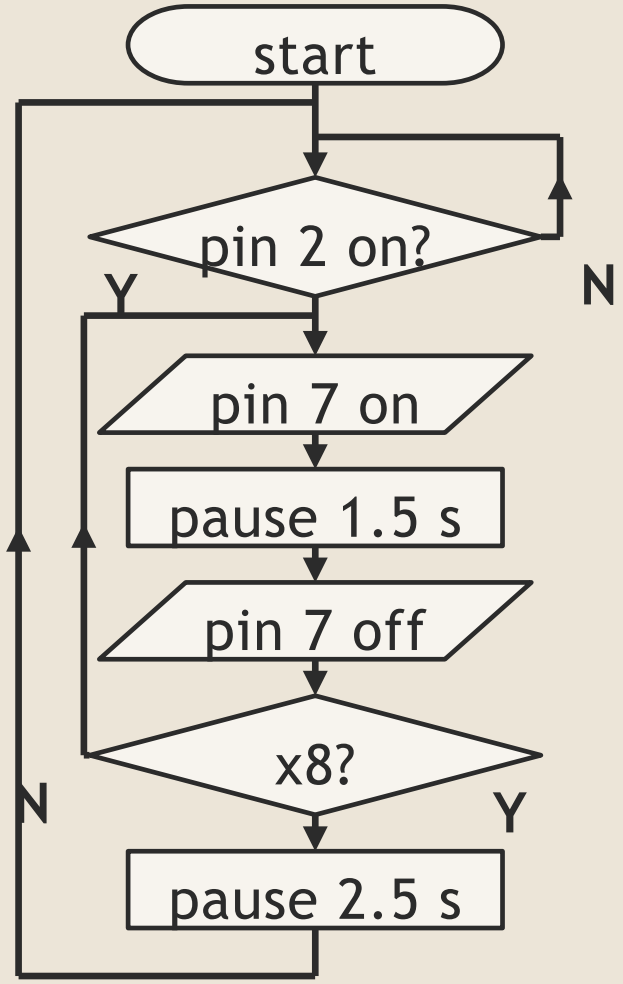


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(5, OUTPUT);
3  }
4  void loop() {
5    for (int count = 0; count < 4; count++) {
6      digitalWrite(5, HIGH);
7      delay(200);
8      digitalWrite(5, LOW);
9      delay(200);
10   }
11   while (true) { }
12 }
```

The Flowchart: Read It

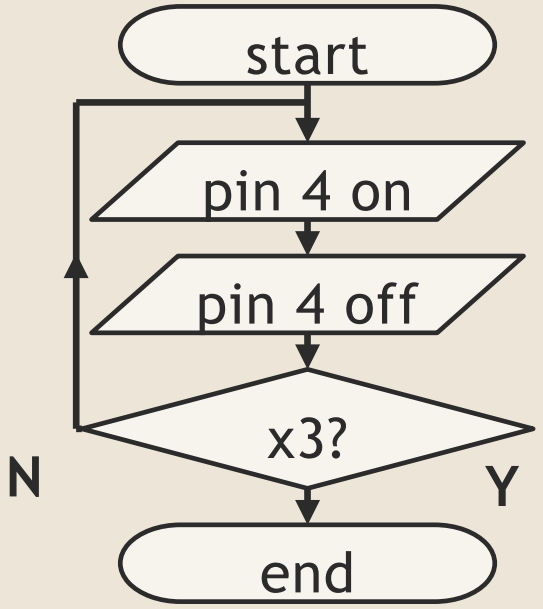


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(2, INPUT);
3    pinMode(7, OUTPUT);
4  }
5  void loop() {
6    while (digitalRead(2) == LOW) { }
7    for (int count = 0; count < 8; count++) {
8      digitalWrite(7, HIGH);
9      delay(1500);
10     digitalWrite(7, LOW);
11   }
12   delay(2500);
13 }
```

The Flowchart: Trace It

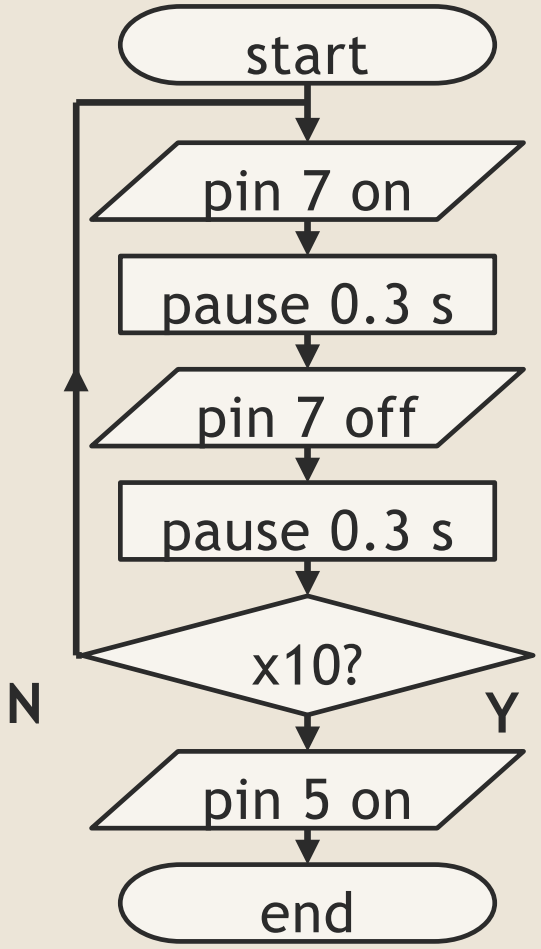


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(4, OUTPUT);
3  }
4  void loop() {
5    for (int count = 0; count < 3; count++) {
6      digitalWrite(4, HIGH);
7      digitalWrite(4, LOW);
8    }
9    while (true) { }
10 }
```

The Flowchart: The Fixed Program

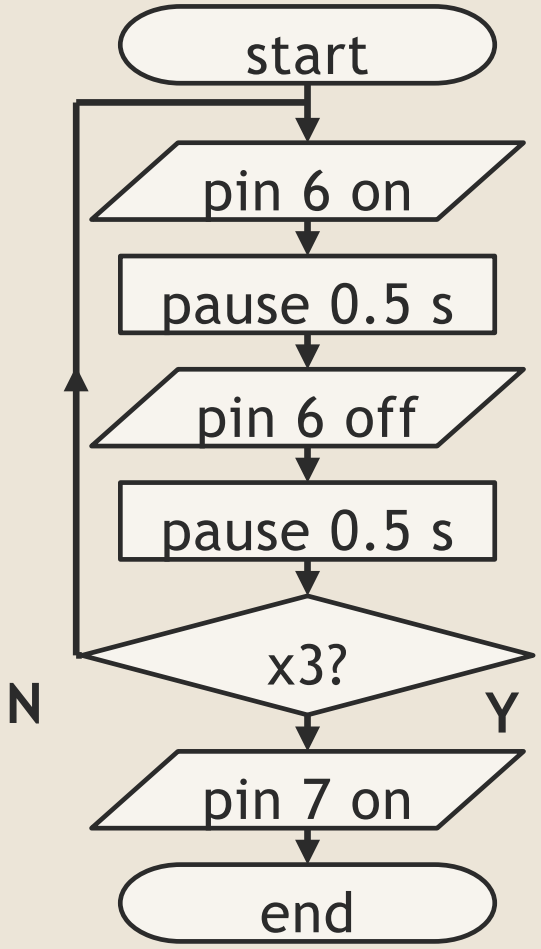


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(5, OUTPUT);
3    pinMode(7, OUTPUT);
4  }
5  void loop() {
6    for (int count = 0; count < 10; count++) {
7      digitalWrite(7, HIGH);
8      delay(300);
9      digitalWrite(7, LOW);
10     delay(300);
11   }
12   digitalWrite(5, HIGH);
13   while (true) { }
14 }
```

The Flowchart: Spot the Mistake, Fixed

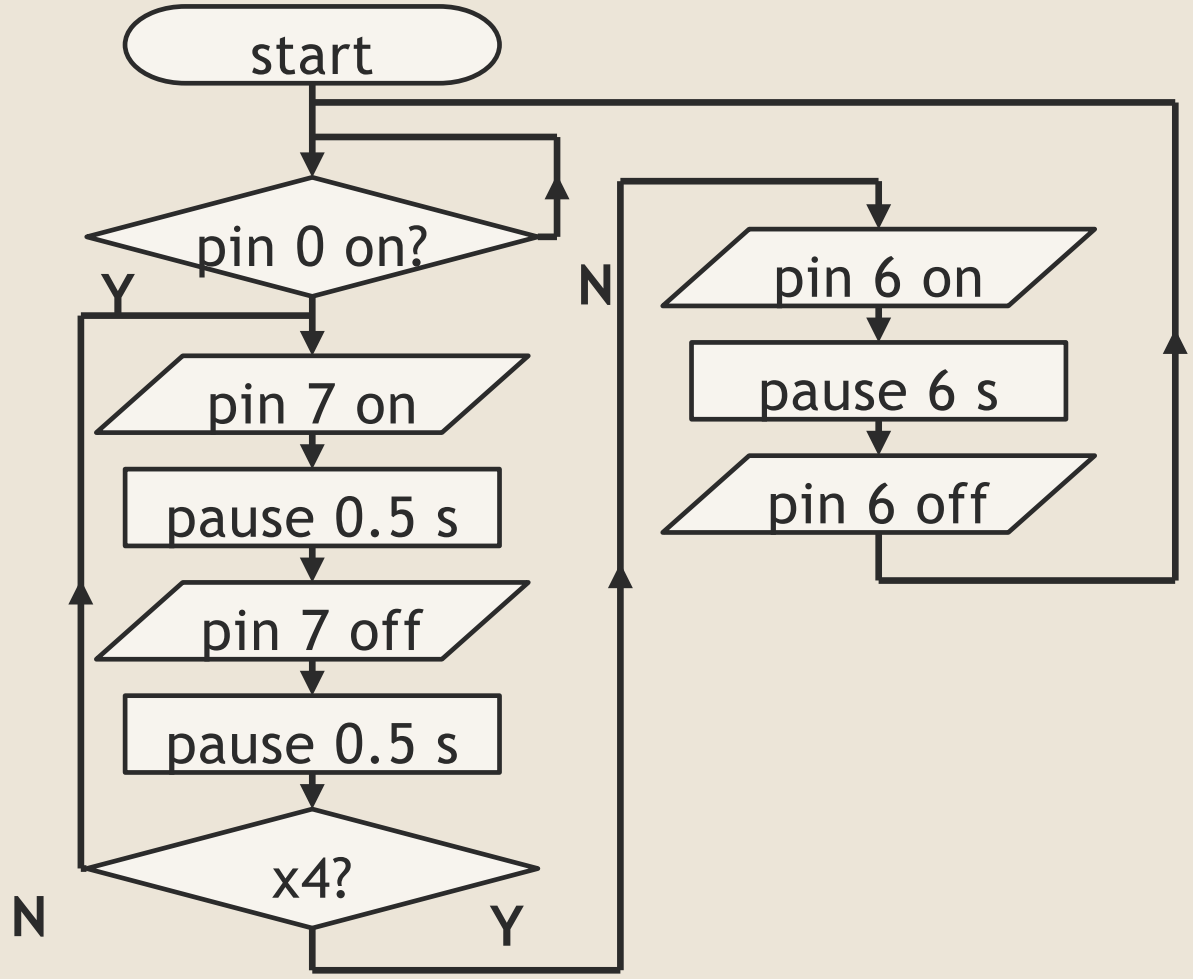


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(6, OUTPUT);
3    pinMode(7, OUTPUT);
4  }
5  void loop() {
6    for (int count = 0; count < 3; count++) {
7      digitalWrite(6, HIGH);
8      delay(500);
9      digitalWrite(6, LOW);
10     delay(500);
11   }
12   digitalWrite(7, HIGH);
13   while (true) { }
14 }
```

The Flowchart: The Level Crossing

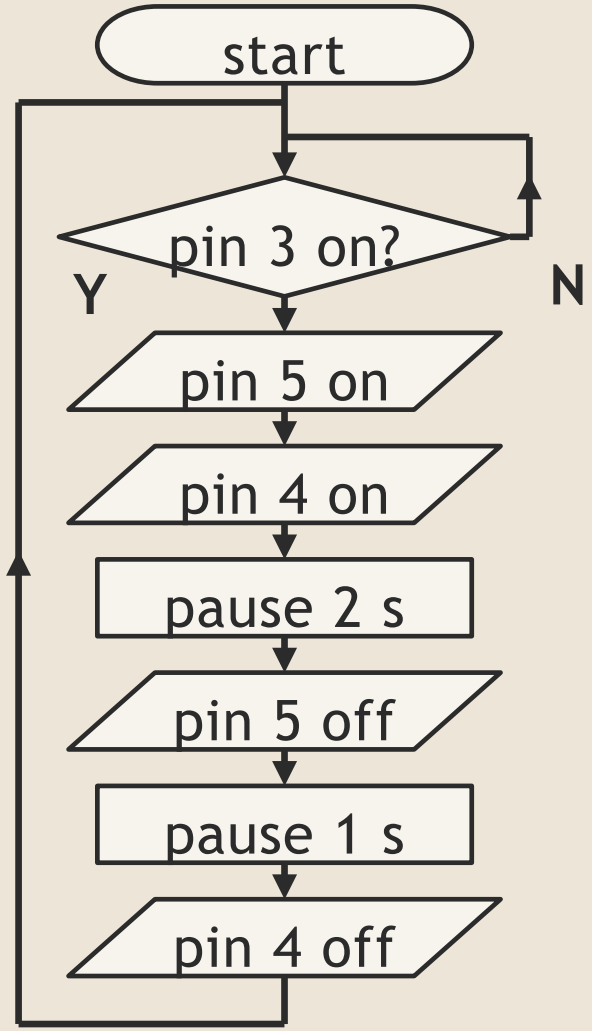


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(0, INPUT);
3    pinMode(6, OUTPUT);
4    pinMode(7, OUTPUT);
5  }
6  void loop() {
7    while (digitalRead(0) == LOW) { }
8    for (int count = 0; count < 4; count++) {
9      digitalWrite(7, HIGH);
10     delay(500);
11     digitalWrite(7, LOW);
12     delay(500);
13   }
14   digitalWrite(6, HIGH);
15   delay(6000);
16   digitalWrite(6, LOW);
17 }
```

The Flowchart: Your Turn

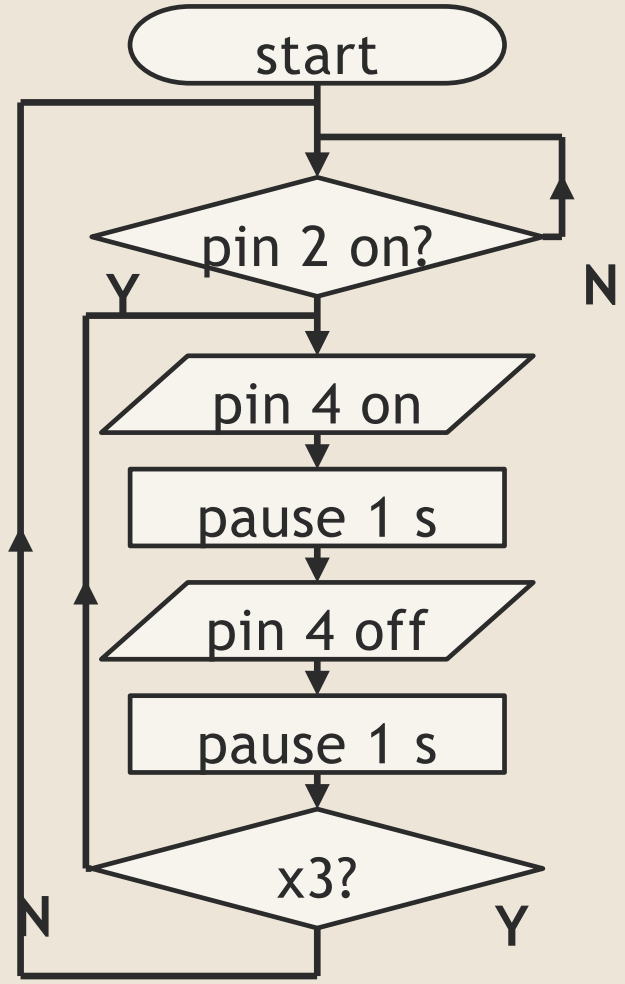


ARDUINO C++

Back

```
1  void setup() {
2    pinMode(3, INPUT);
3    pinMode(4, OUTPUT);
4    pinMode(5, OUTPUT);
5  }
6  void loop() {
7    while (digitalRead(3) == LOW) { }
8    digitalWrite(5, HIGH);
9    digitalWrite(4, HIGH);
10   delay(2000);
11   digitalWrite(5, LOW);
12   delay(1000);
13   digitalWrite(4, LOW);
14 }
```

The Flowchart: Your Program



ARDUINO C++

Back

```
1  void setup() {
2    pinMode(2, INPUT);
3    pinMode(4, OUTPUT);
4  }
5  void loop() {
6    while (digitalRead(2) == LOW) { }
7    for (int count = 0; count < 3; count++) {
8      digitalWrite(4, HIGH);
9      delay(1000);
10     digitalWrite(4, LOW);
11     delay(1000);
12   }
13 }
```