Microcontroller or hard-wired?

LEARNING INTENTION

We are learning to compare microcontroller and hard-wired control, and to connect input and output devices to microcontroller pins.

SUCCESS CRITERIA — I CAN

- ☐ compare a microcontroller system with a hard-wired system
- ☐ describe what input and output pins do
- ☐ connect a switch between 5 V and an input pin
- ☐ connect an output device between an output pin and 0 V

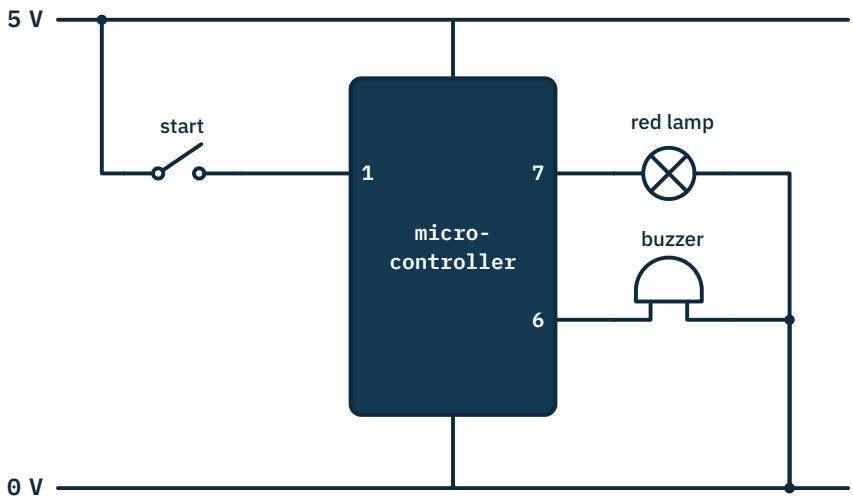
Hard-wired or microcontroller?

	Hard-wired (gates, timers)	Microcontroller
How it works	fixed by the wiring	set by a stored program
Changing it	rewire or new board	reprogram
Parts	many chips and components	one chip
Good for	very simple, fast jobs	sequences, timing, counting

Both can control the same outputs. A microcontroller is usually smaller and easier to change. A hard-wired circuit can be simpler for one fixed job.

Pins: inputs and outputs

Each pin has a number. The program sets each pin as an **input** (reads a switch or sensor) or an **output** (switches a device on or off).



Switch 5 V → pin 1; lamp pin 7 → 0 V; buzzer pin 6 → 0 V

Microcontroller or hard-wired?

WORKED EXAMPLE **Wiring a start switch and a red lamp**

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
start switch on pin 1 red lamp on pin 7	circuit connections	input: 5 V → switch → pin output: pin → device → 0 V	switch between 5 V and pin 1 lamp between pin 7 and 0 V	**2 connections**

When the switch closes, pin 1 reads on (high). When pin 7 is switched on, current flows through the lamp to 0 V.

SHORT CIRCUIT

× WHAT EXAMINERS SAW

Some candidates wired the switch or the output device to the wrong rail, so the circuit could not work.

√ THE FIX

Input switch: between 5 V and the input pin. Output device: between the output pin and 0 V.

Microcontroller circuit questions, MI 2025 Q9(b).

Three microcontrollers, one idea

You may use PIC (PICAXE), Arduino or micro:bit in class. Pin names differ, but the idea is the same. In the exam, use the pin numbers in the question.

	PIC (PICAXE)	Arduino Uno	micro:bit
Input pin example	C.1	D2	P0
Output pin example	B.7	D13	P1
Supply	5 V	5 V	3 V

PICAXE BASIC

```
high B.7
pause 500
low B.7
```

Arduino C++

```
digitalWrite(13, HIGH);
delay(500);
digitalWrite(13, LOW);
```

micro:bit Python

```
pin1.write_digital(1)
sleep(500)
pin1.write_digital(0)
```

You do not write code in the exam. You read programs and draw flowcharts.

Microcontroller or hard-wired?

SHORT CIRCUIT

× WHAT EXAMINERS SAW

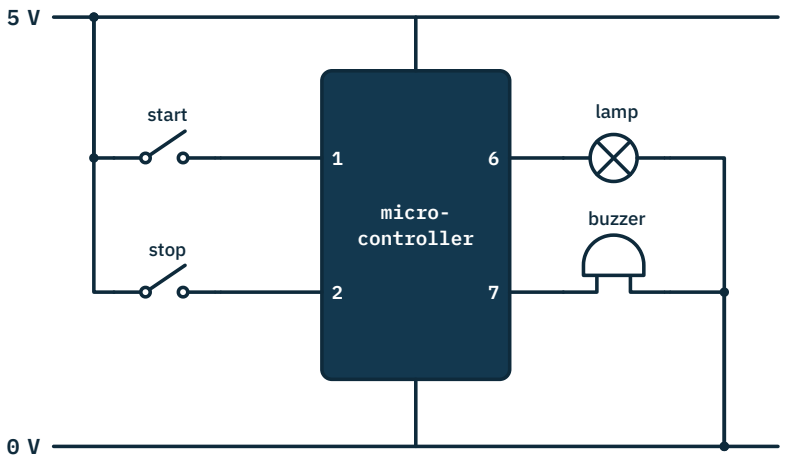
Some candidates renamed the microcontroller pins to match the pin numbers in the task, instead of choosing a microcontroller that had those pins.

√ THE FIX

Use the pin numbers you are given. In a simulation, pick a microcontroller with the right pins; do not relabel them.

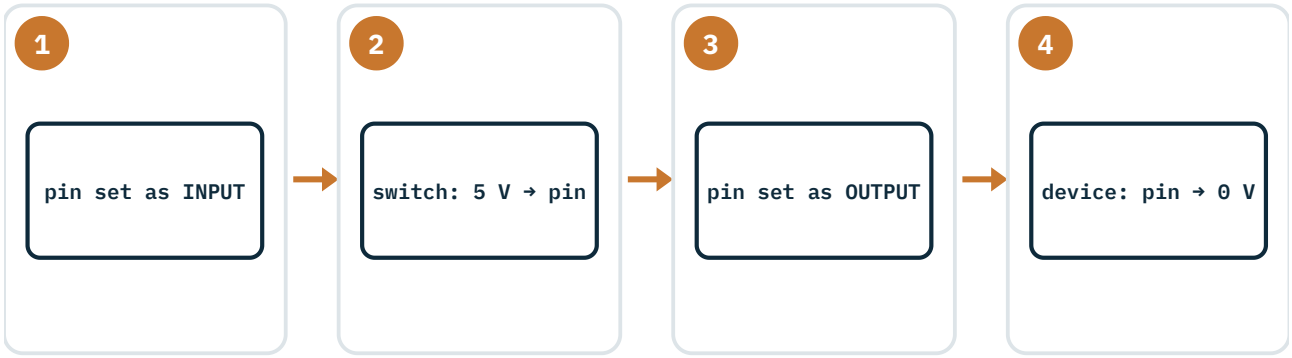
Course report 2024 (assignment Task 2a).

Wiring inputs and outputs



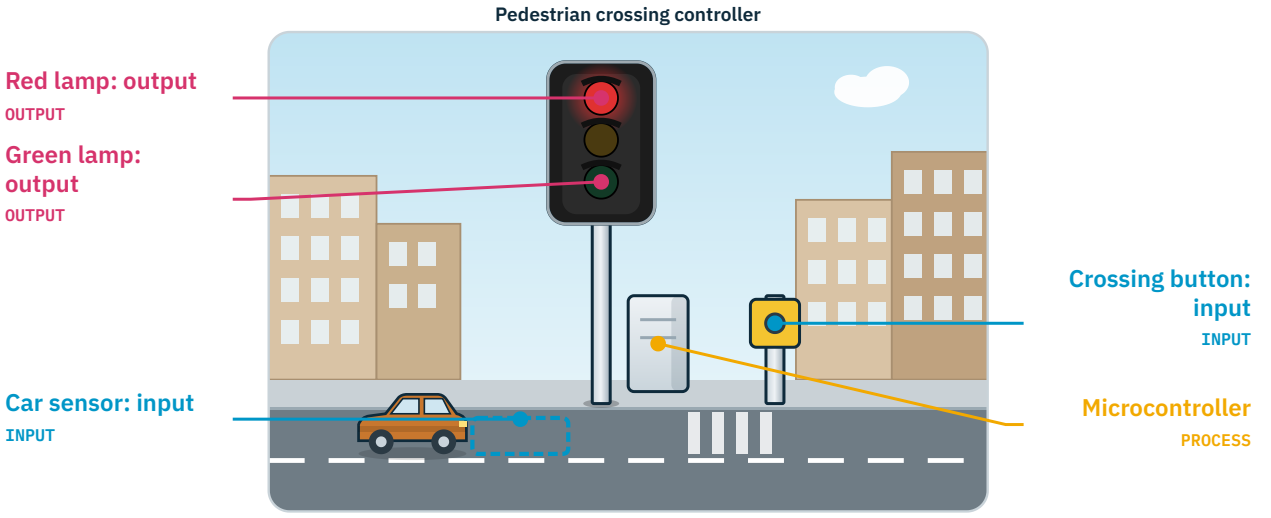
Two switches and two outputs

PINS IN FOUR STEPS



1. Program sets the pin direction
2. Pressed: pin reads 1 (high)
3. Program switches the pin on
4. Current flows through the device

Microcontroller or hard-wired?



WORKED EXAMPLE Wiring two inputs and two outputs

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
start switch pin 1, stop switch pin 2 lamp pin 6, buzzer pin 7	connections	switches: 5 V → pin outputs: pin → 0 V	pins 1 and 2 from 5 V via switches pins 6 and 7 to 0 V via lamp and buzzer	**4 connections**

WORKED EXAMPLE Choosing the board

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
task uses pins 0, 5, 6 and 7	what to do in the simulator	keep the given pins	pick a microcontroller that has pins 0, 5, 6, 7 do not rename pins	**Use the given pins**

Course report 2024.

Microcontroller or hard-wired?

WRONG

Lamp: 5 V → lamp → pin 6

Lamp would be on all the time / wrong rail.

RIGHT

Lamp: pin 6 → lamp → 0 V

Outputs connect from the pin to 0 V.

REAL ENGINEERING · STRATHMORE FERRY RAMP

The ramp controller at Strathmore terminal (fictional) once used relays and timers. It was replaced by a microcontroller board.

The new board had far fewer parts. When the safety rules changed, engineers updated the program instead of rewiring the cabinet.

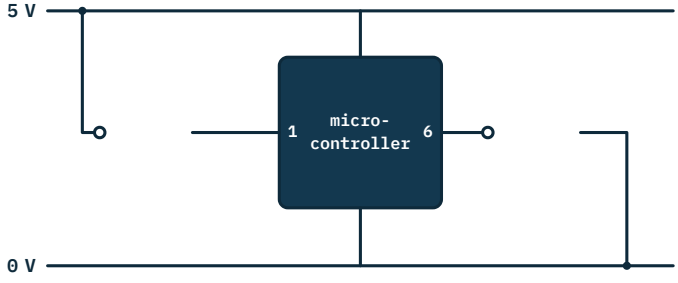
PROBE · QUICK CHECKS

1. Where does an input switch connect? _____
2. Where does an output lamp connect? _____
3. Change a microcontroller system how? _____

EXAM READY · 5 MARKS

1 **State** one advantage of a microcontroller system over a hard-wired system. **[1]**

2 A push switch is connected to pin 1 and a buzzer to pin 6. **Complete** the circuit. **[2]**



Microcontroller or hard-wired?

3 **Explain** why a hard-wired circuit may be chosen for a very simple alarm. **[2]**