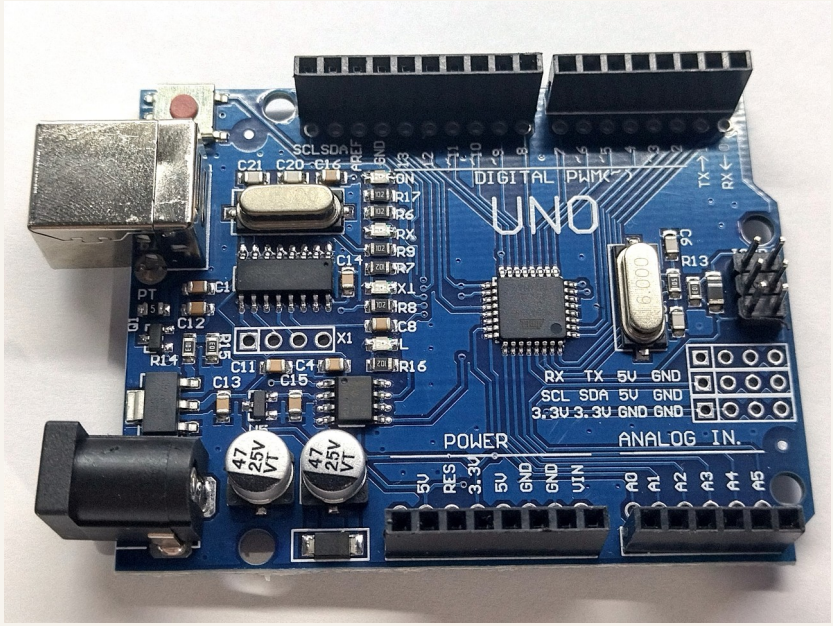
Daily Review

1	A transistor in a circuit acts as a…	Switch
2	A relay lets a small current switch…	A separate, bigger circuit
3	A diode across a relay coil protects the…	Transistor
4	It gets dark. An LDR's resistance…	Rises
5	Three parts of a system diagram?	Input, process, output

Microcontrollers

One chip runs a washing machine, a bus door and a packing line.



National 5 Engineering Science

How does a washing machine know when to spin?



PART 1

What a Microcontroller Is

One chip, one program, a whole machine.

By the end of this part…



1. I can describe what a microcontroller is
2. I can give commercial and industrial examples
3. I can give advantages and disadvantages compared with hard-wired control

What Is a Microcontroller?

Microcontroller

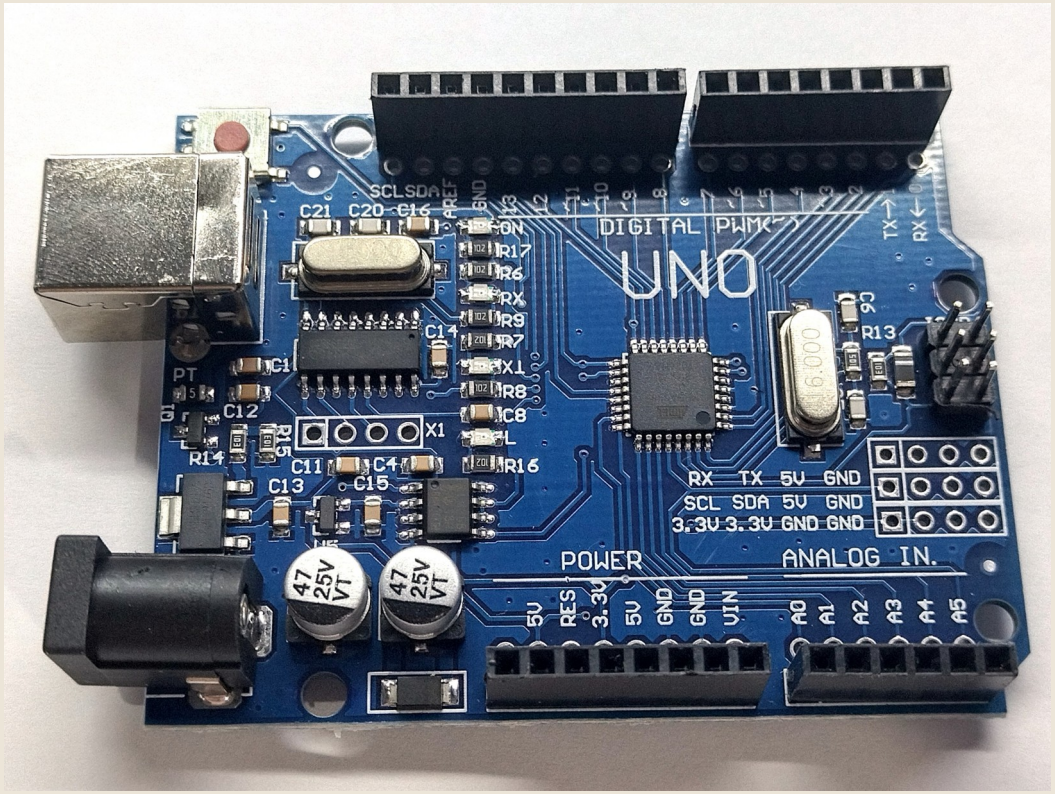
a small, programmable chip that controls a system

It runs

a program stored in its memory

It reads

inputs, and switches outputs



Input, Process, Output

Input

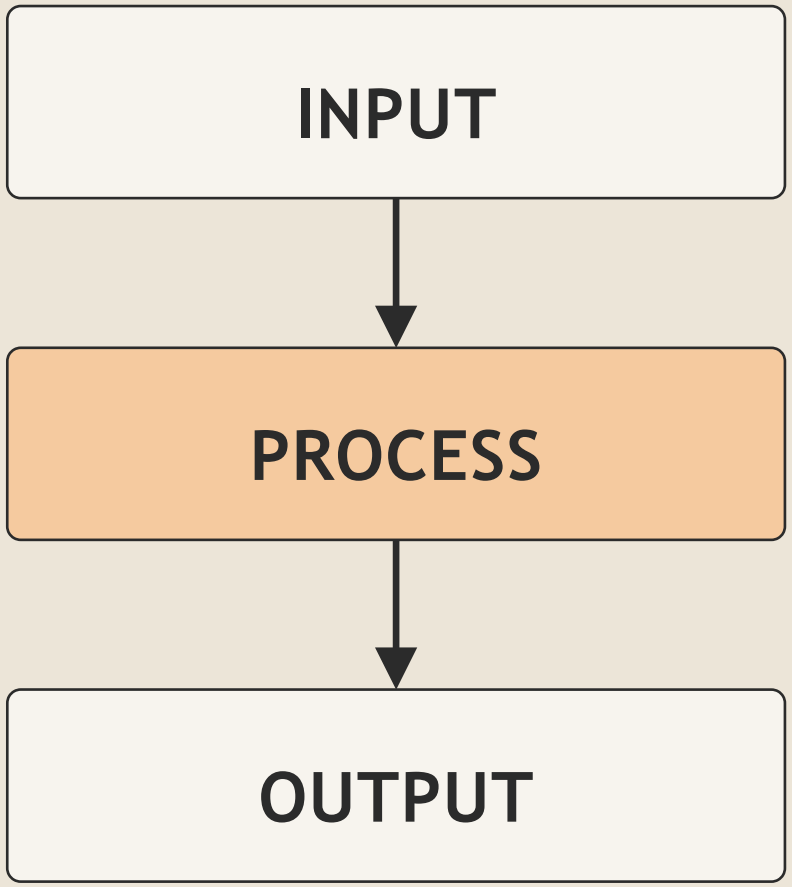
a switch or a sensor

Process

the microcontroller and its program

Output

a lamp, buzzer or motor



Where You Meet Them



Commercial

ticket machine



Industrial

packing line



Transport

bus doors



Home

smart lighting

Which Sector?

1	An alarm panel in a shop	Commercial
2	A robot welder in a car factory	Industrial
3	Anti-lock brakes on a car	Transport
4	Central heating control	Home
5	A packaging machine	Industrial

Hard-Wired Control

Hard-wired

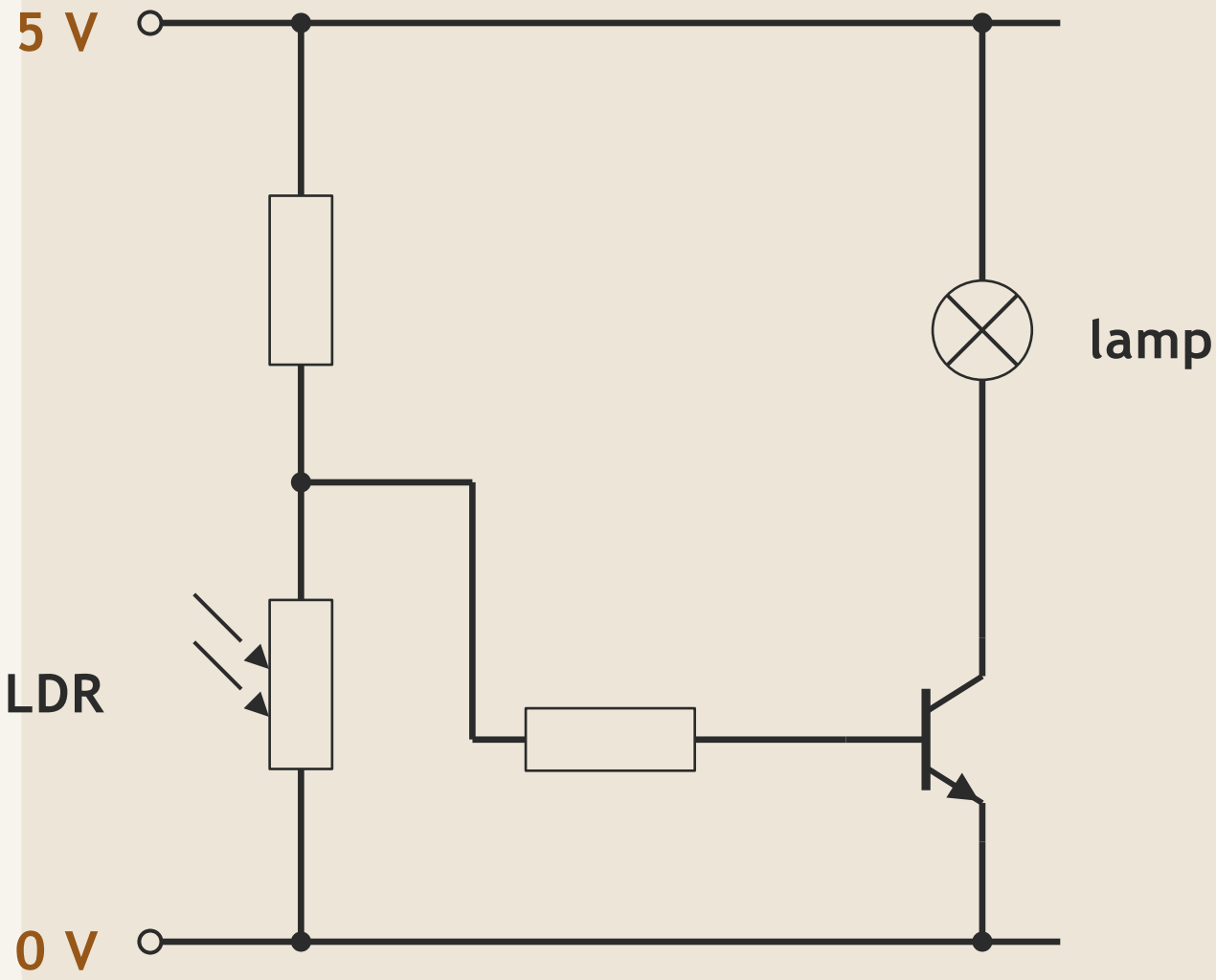
fixed components and wires

The job is

in the wiring

Change the job

new parts, new wiring



Programmable Control

Programmable

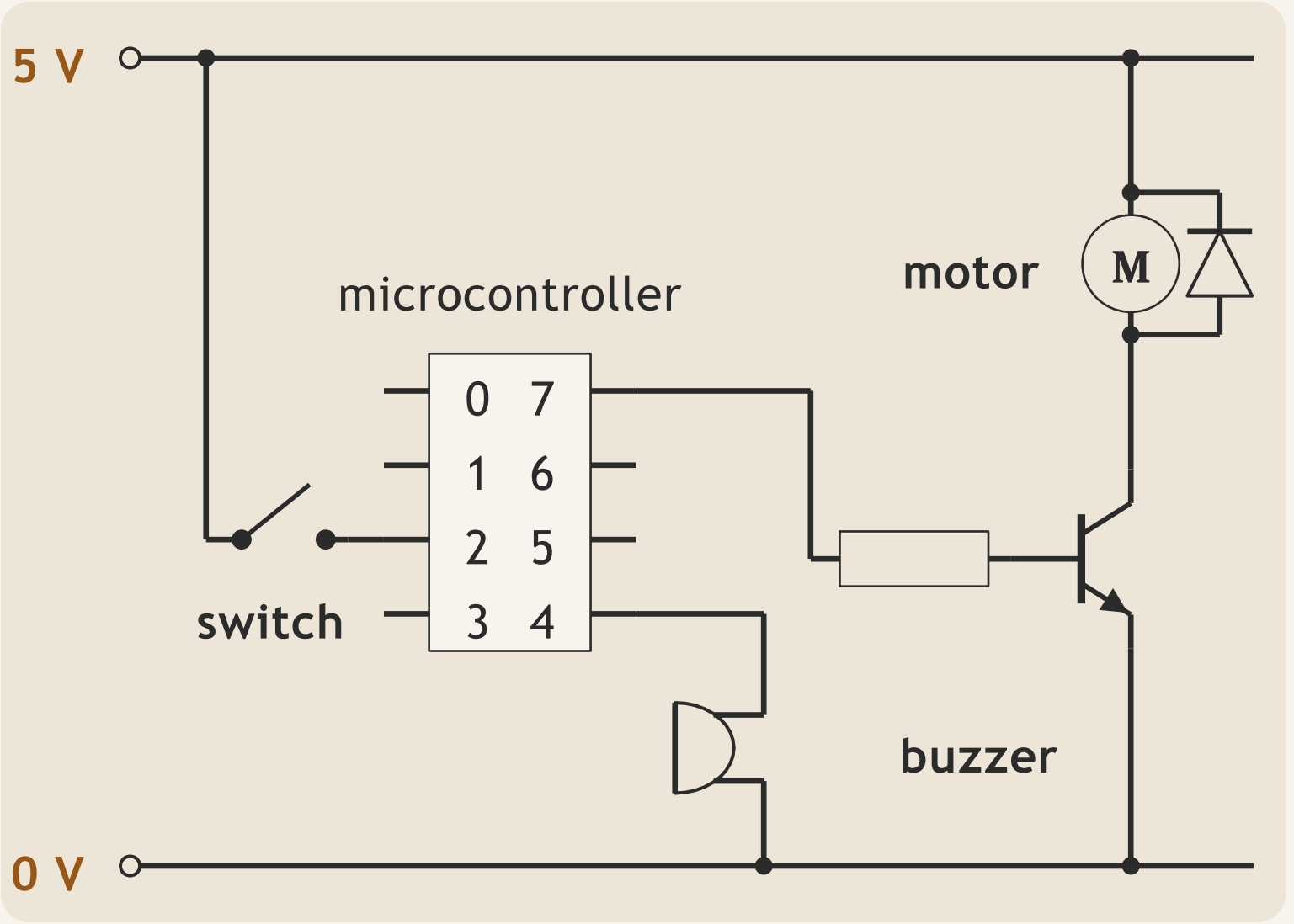
a microcontroller and a program

The job is

in the program

Change the job

change the program



Advantages

Can be reprogrammed

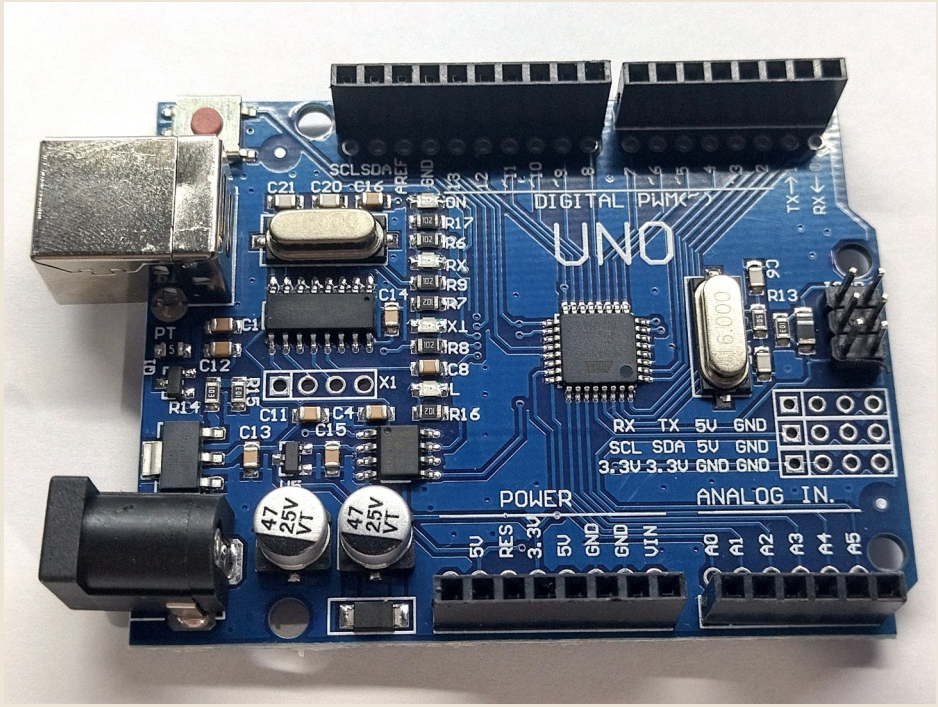
change the program, not the wiring

Can be re-used

one board, many products

Fewer components

so more reliable, faster to assemble



Disadvantages

Needs a programmer

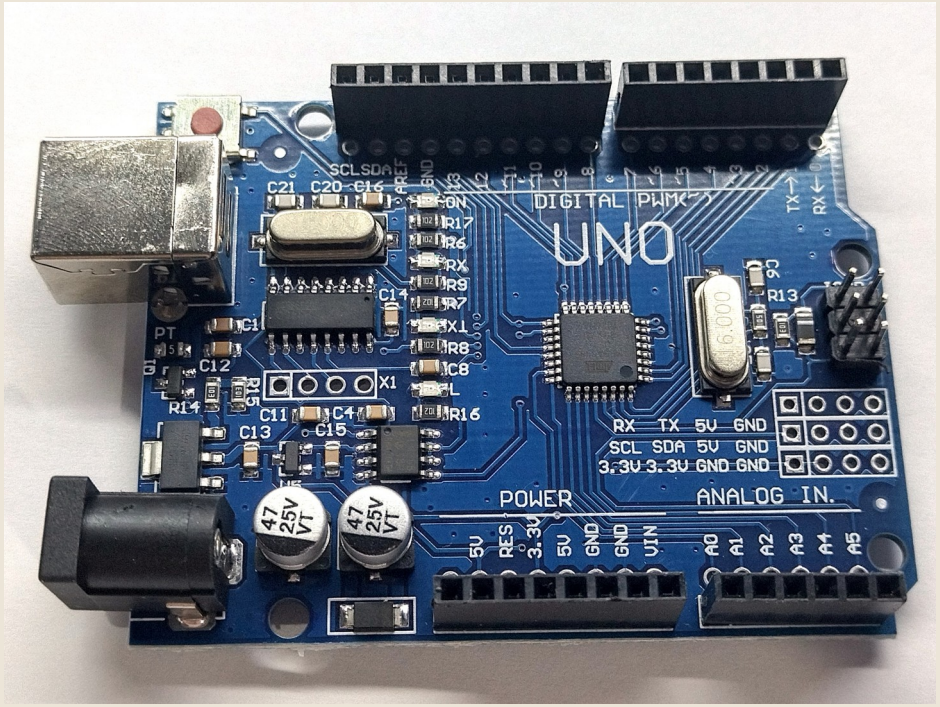
someone must write and test the program

Needs a power supply

the chip needs one to run

Harder to follow

you cannot see the job by looking at the parts



Watch Out: “Easier to Change”

THE MISTAKE

- It is easier to change.
- It is cheaper.
- It is programmable.

THE CORRECT ANSWER

- It can be reprogrammed, with no rewiring.
- It needs fewer components, so it costs less.
- One board can be re-used for a new job.

Model Answer: Describe Two Advantages (2 marks)

Describe two advantages of a microcontroller over a hard-wired circuit for bus doors.

1 (1 mark)

The door times can be reprogrammed with no rewiring.

2 (1 mark)

Fewer components, so the doors are more reliable.



Model Answer: Explain Why (2 marks)

Explain why a microcontroller is used in a ticket machine.

Cause (1 mark)

The program can be updated

Effect (1 mark)

so new fares are added with no change to the circuit.



Your Turn: Answer the Same Way



1. Smart lighting: describe one advantage.

Can be reprogrammed, with no rewiring

2. A packing line: explain why it uses one.

Fewer parts, so it is more reliable

3. How many marks for 'it is cheaper'?

0: say why it costs less

Spot the Mistake

Describe two advantages of a microcontroller for a car-park barrier.

A pupil wrote

1 It is cheaper. 2 It is programmable.

Your job

How many marks? Why? Rewrite it.

TASK 1: Microcontrollers in Use



Booklet page 3, TASK 1

For each product, say why a microcontroller suits it.
Use the words from the Advantages slide.

5 min

TASK 1: Answers

1	Microwave oven	Runs a timed sequence; checks the door
2	Traffic lights	Timings changed in the program, no rewiring
3	Robot arm in a factory	Runs motors in order; can be reprogrammed
4	Smart heating thermostat	Reads a sensor; settings changed in the program

Past Papers: Advantages

Past papers

Year	Question
2021	Q7(b)
2022	Q14(c)
2025	Q8(c)
2026	Q13(e)

By topic

Checkpoint



1. What is a microcontroller?
2. Give one disadvantage.
3. Why use one board for 3 alarm models?

A chip that runs a stored program

Someone must write the program

It can be re-used: just load a new program

Plenary: Part 1

1. A microcontroller runs a stored…

   Program

2. Give an industrial example.

   Packing line, robot arm, welder

3. Give two advantages the exam accepts.

   Reprogrammable; fewer parts, so reliable

Plenary: Part 1



4 One disadvantage?

Needs a programmer (or power supply)

5 What scores 0 on its own?

Easier to change, cheaper, fewer parts

Look back — by the end of this part…



1. I can describe what a microcontroller is
2. I can give commercial and industrial examples
3. I can give advantages and disadvantages compared with hard-wired control

Daily Review



1. One advantage of a microcontroller?
2. 'Easier to change' alone scores…
3. A transistor switches on at a base voltage of…
4. The base resistor limits the…
5. A packing line: commercial or industrial?

It can be reprogrammed

0 marks

About 0.7 V

Base current

Industrial

PART 2

Wiring to the Pins

The lamp is too dim. What do you add?

By the end of this part…



1. I can wire an input switch to a pin
2. I can wire an output to a pin
3. I can wire a transistor driver to a pin
4. I can complete a wiring diagram from an I/O table

The Exam's Microcontroller

8 pins

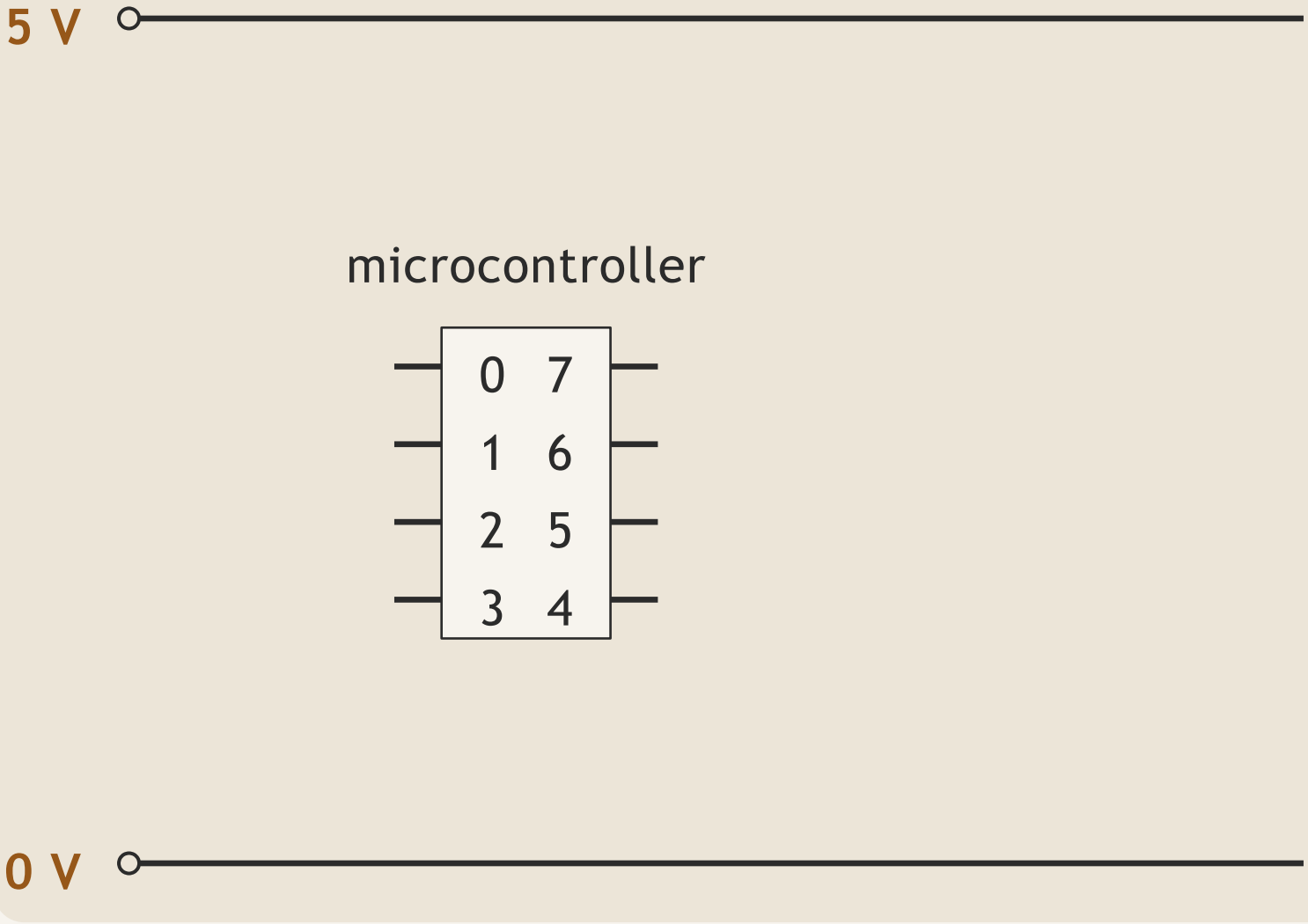
each an input or an output

The I/O table

says which

In our room

inputs 2, 3;
outputs 4 to 7



Wiring an Input

Switch

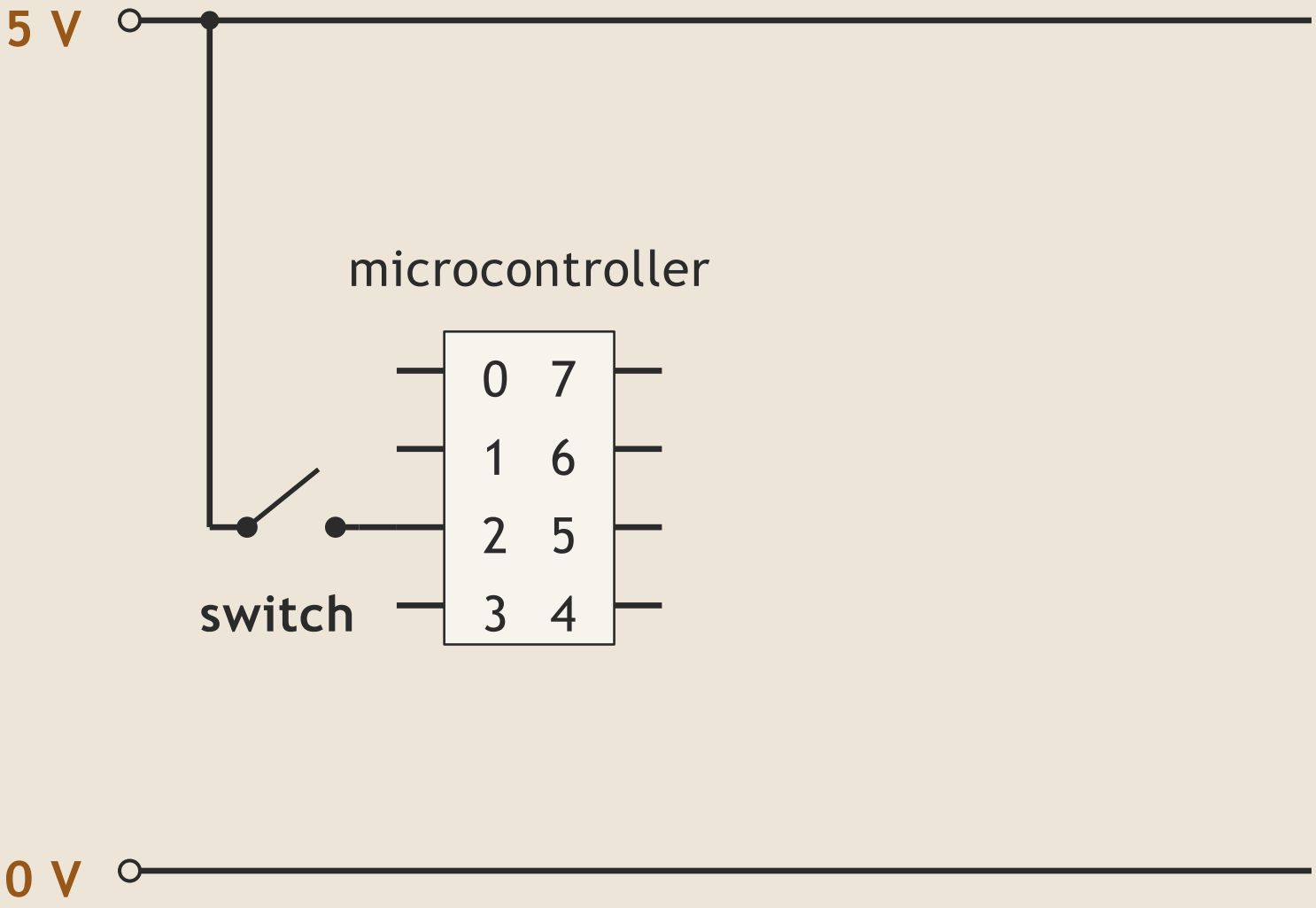
from 5 V to the pin

Pressed

the pin gets 5 V

The program

reads the input as on



Wiring an Output

Output

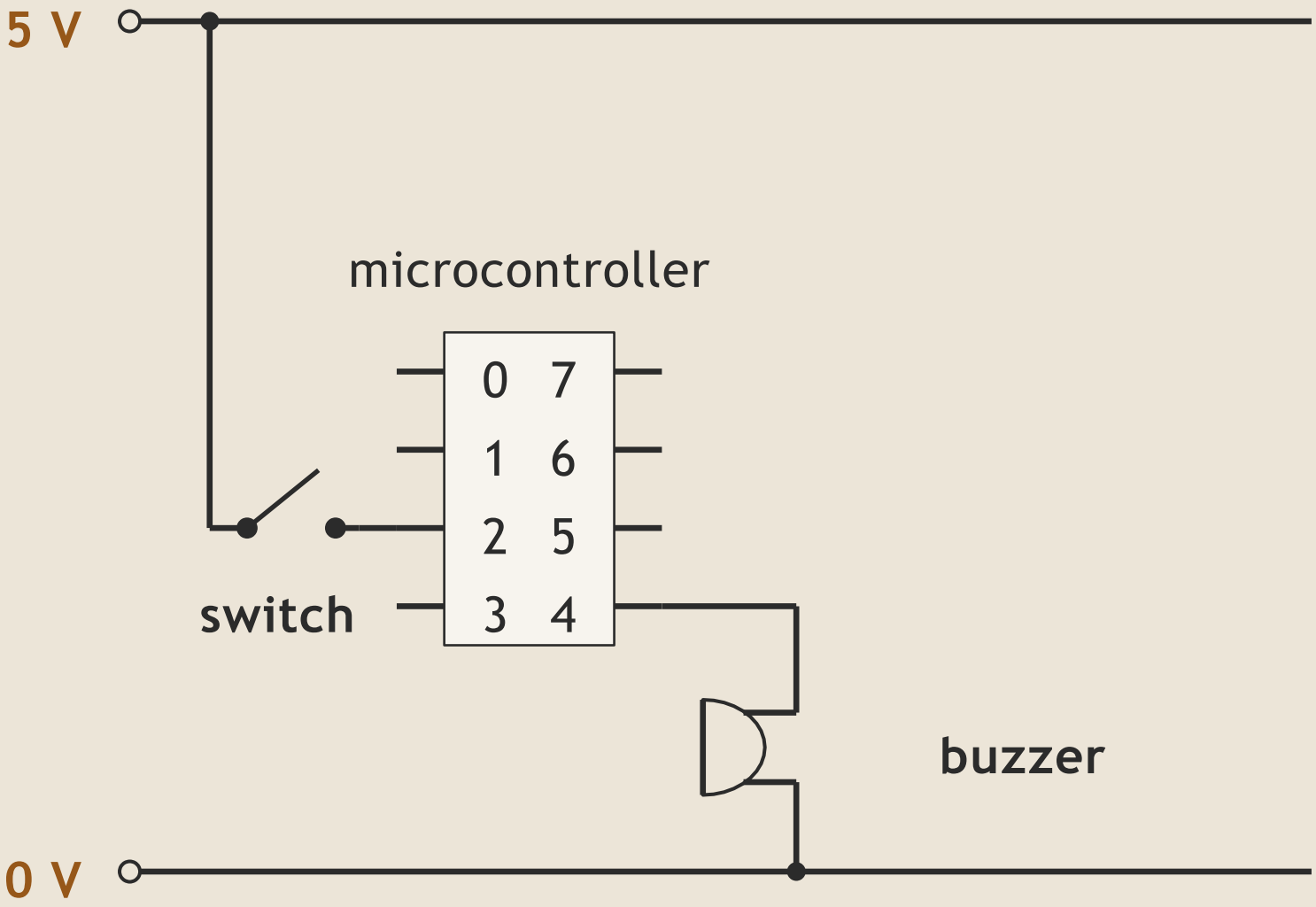
from the pin to 0 V

Switched on

5 V on the pin

Current flows

the buzzer sounds



A Motor Needs a Transistor

A pin gives

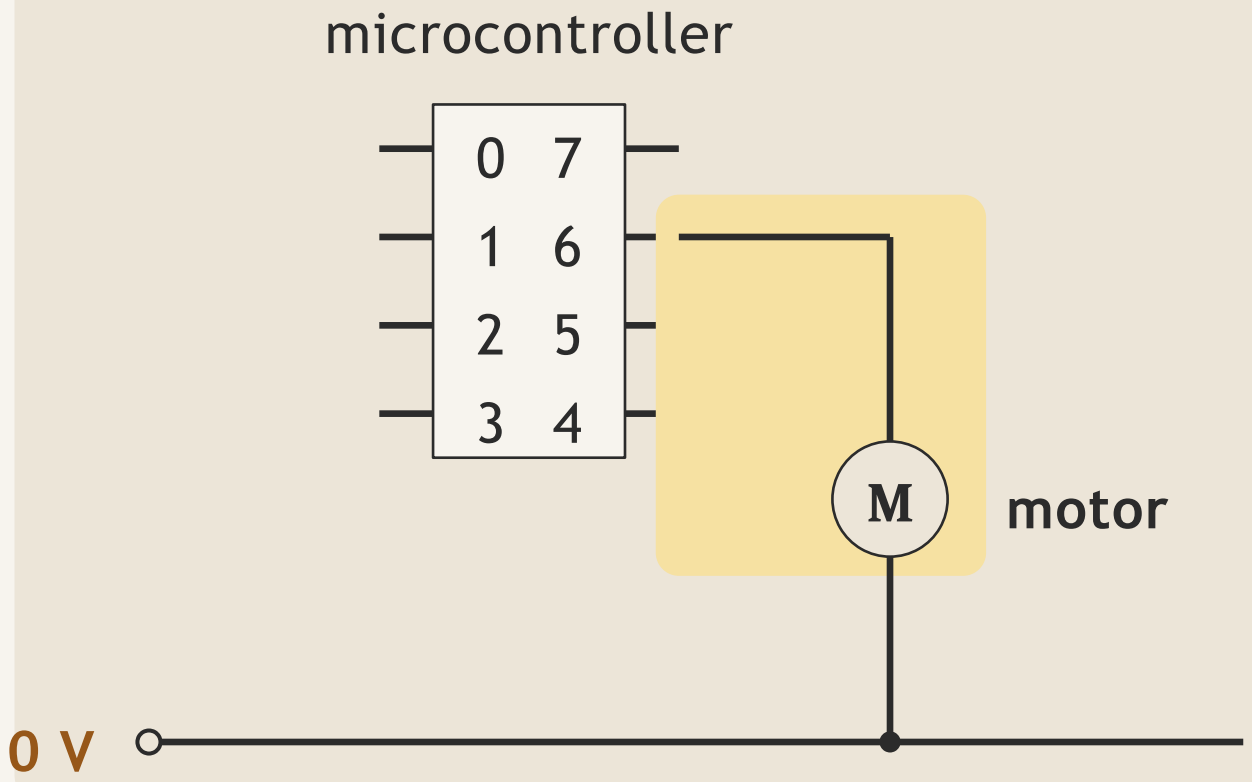
a small current, about 20 mA

A motor needs

much more

Add a transistor

write 'transistor': 'driver' alone scores 0



The Transistor Driver

Base lead

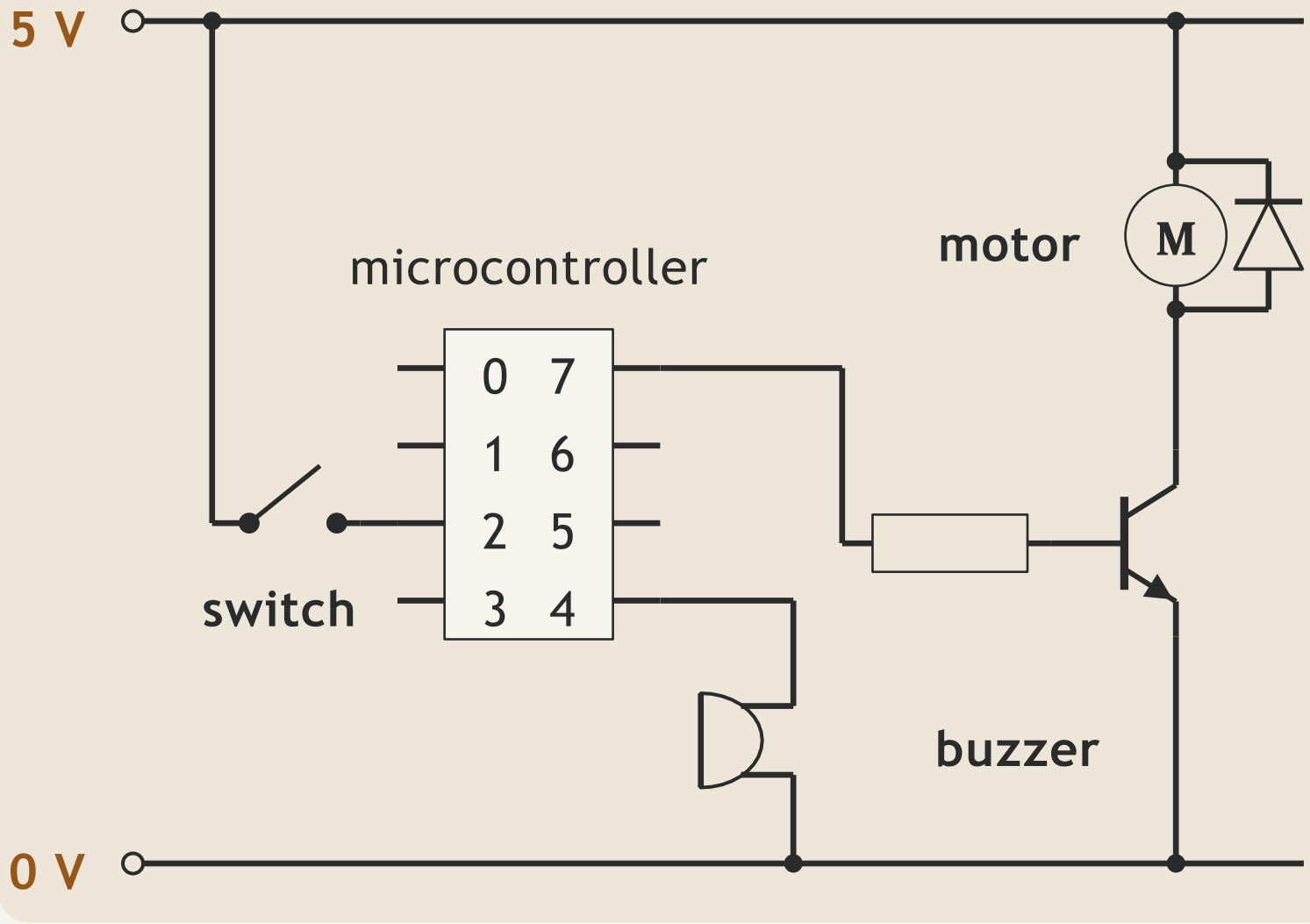
pin → resistor → base

Collector

motor, with a diode across it

Emitter

to 0 V



Model Answer: Complete the Wiring (3 marks)

Input, pin 2

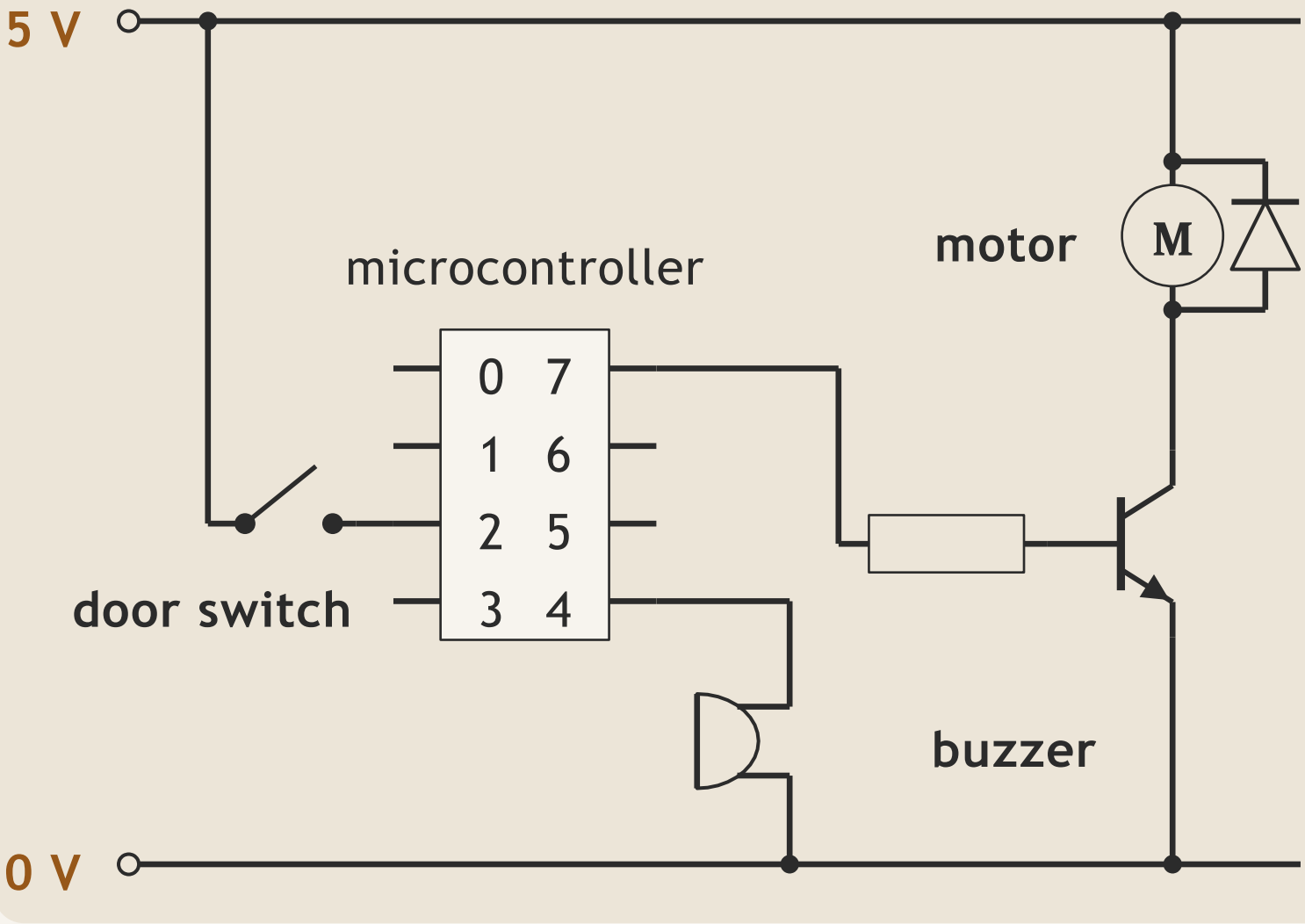
door switch

Output, pin 4

buzzer

Output, pin 7

motor, via a transistor



The Same Circuit in the Simulator

Same I/O table

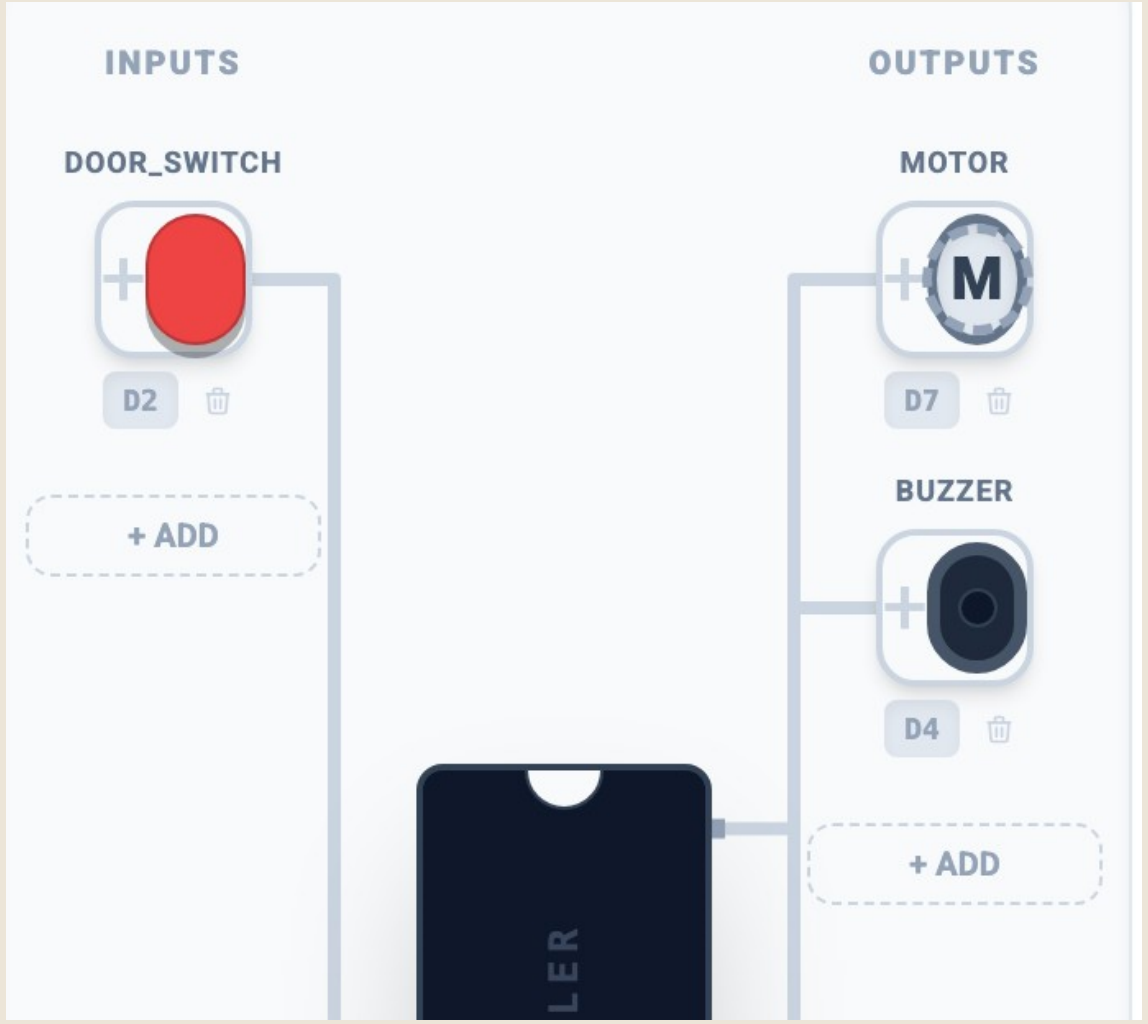
input D2; outputs D4 and D7

Each part

on its own pin

The sim does not show

the transistor or the power rails



Your Turn: Complete the Wiring

Input, pin 3

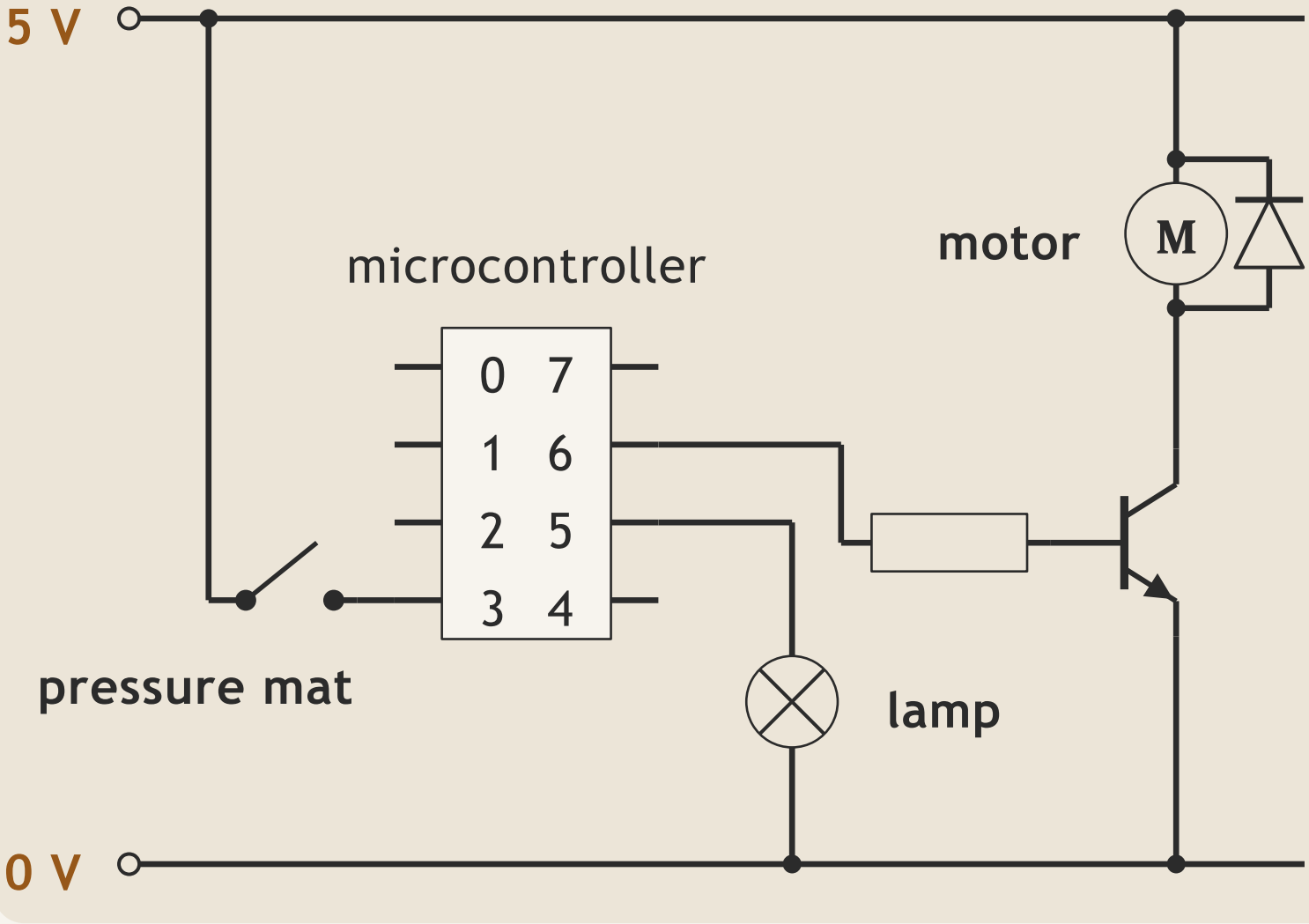
pressure mat

Output, pin 5

lamp

Output, pin 6

motor, via a transistor



Spot the Mistake

I/O table

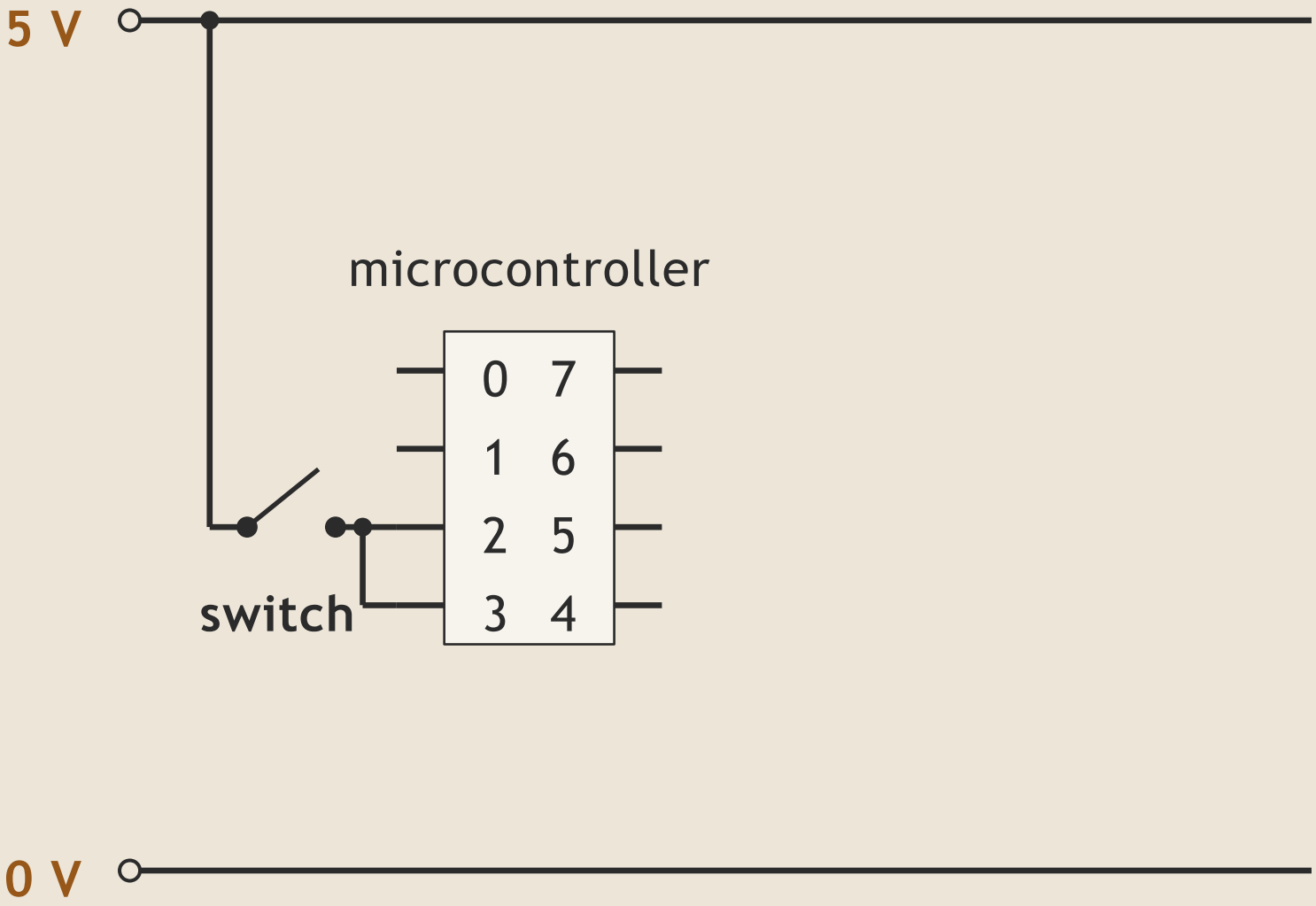
switch on pin 2

A pupil drew

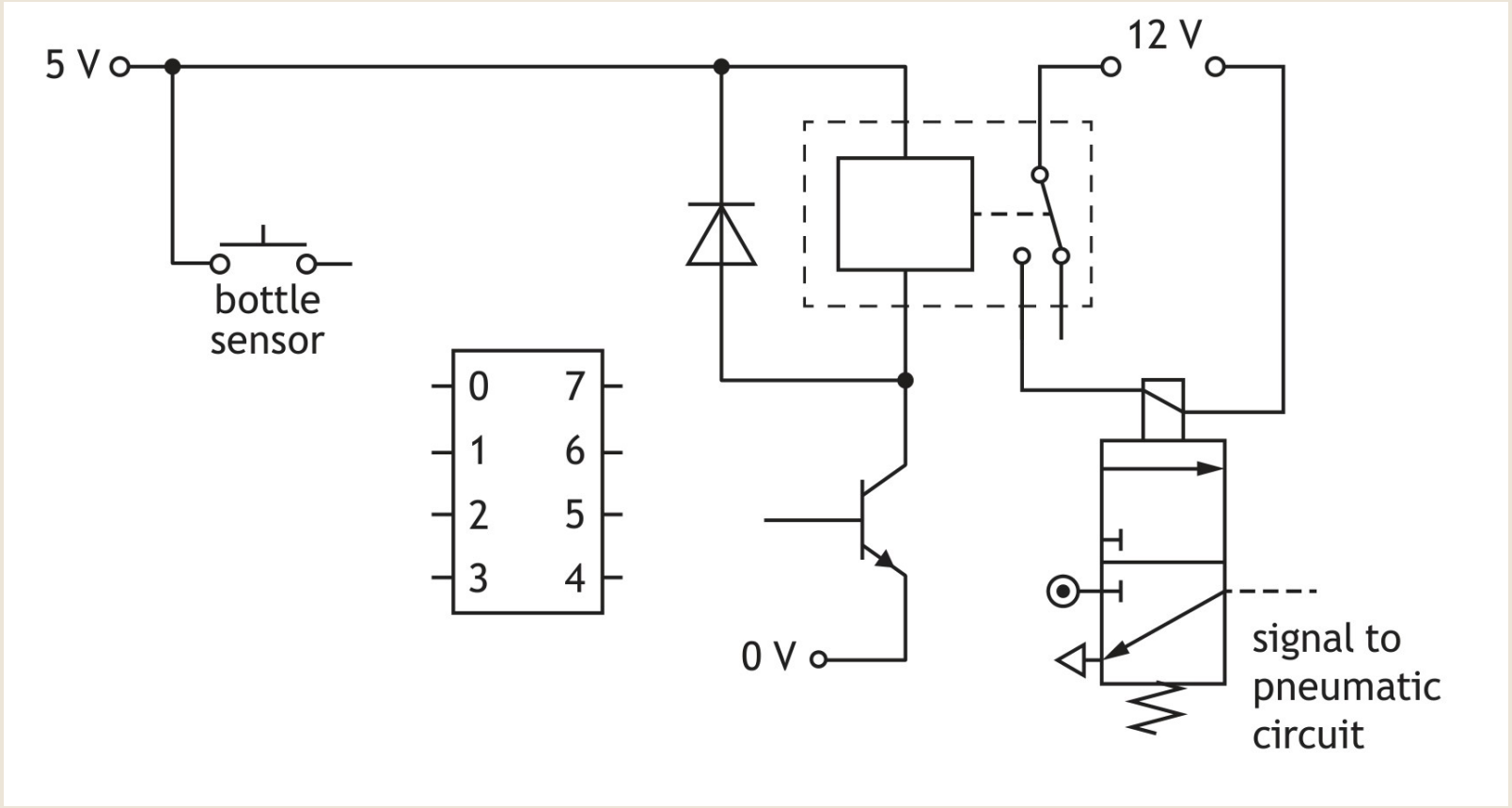
this

Your job

find the mistake. How many marks does it lose?



Past Papers: Wiring



2023 Q9(d) (2 marks)

Past Papers: Answers

1. 2023 Q9(d)

2. 2023 Q9(d), also

Sensor to pin 2 (1); pin 7 to base (1)

Do not wire any extra pins

Checkpoint

1. Where does an input switch connect?
2. Where does a buzzer connect?
3. Why can't a motor go straight on a pin?

From 5 V to the pin

From the pin to 0 V

Too little current, so add a transistor

Plenary: Part 2

1	An input switch goes from … to the pin.	5 V
2	A small output goes from the pin to…	0 V
3	A motor needs what between it and the pin?	A transistor
4	What goes across the motor?	A protection diode
5	A wire to a pin not in the I/O table…	Loses the mark

Extension

EXTRA PRACTICE



1	Why is a diode put across the motor?	Protects the transistor from a voltage spike
2	Why the resistor in the base lead?	It limits the base current
3	Can a 12 V lamp go straight on pin 5?	No: use a transistor and a 12 V supply

Look back — by the end of this part…



1. I can wire an input switch to a pin
2. I can wire an output to a pin
3. I can wire a transistor driver to a pin
4. I can complete a wiring diagram from an I/O table

LOOKING AHEAD

Lesson 2: Flowcharts

The wiring is done. How do we tell the chip what to do?

Course Specification

Digital electronic control systems

- examples of using microcontrollers in commercial and industrial applications
- advantages and disadvantages of microcontroller-based control systems, compared to a hard-wired electronic equivalent

Wiring to pins: asked in the 2023 and 2025 papers.

Credits (1 of 4)

The big question (A washing machine): Photo: Fanti Salms, CC BY-SA 3.0, via Wikimedia Commons

Title slide (Arduino Uno board): Photo: JrawX, CC0, via Wikimedia Commons

What Is a Microcontroller? (Arduino Uno board): Photo: JrawX, CC0, via Wikimedia Commons

Where You Meet Them (ticket machine): Photo: Infrastorian, CC0, via Wikimedia Commons

Where You Meet Them (packing line): Photo: SimónK, CC BY-SA 4.0, via Wikimedia Commons

Where You Meet Them (bus doors): Photo: Leif Jørgensen, CC BY-SA 4.0, via Wikimedia Commons

Where You Meet Them (smart lighting): Photo: Danielrosehill, CC BY 4.0, via Wikimedia Commons

Credits (2 of 4)

Advantages (marking-instruction wording): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q7(b), 2022 Q14(c), 2025 Q8(c).

Advantages (Arduino Uno board): Photo: JrawX, CC0, via Wikimedia Commons

Disadvantages (Arduino Uno board): Photo: JrawX, CC0, via Wikimedia Commons

Watch Out (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q7(b), 2022 Q14(c), 2025 Q8(c).

Model Answer: Describe (bus doors): Photo: Leif Jørgensen, CC BY-SA 4.0, via Wikimedia Commons

Model Answer: Explain (ticket machine): Photo: Infrastorian, CC0, via Wikimedia Commons

Spot the Mistake (marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science marking instructions: 2021 Q7(b), 2022 Q14(c), 2025 Q8(c).

Credits (3 of 4)

A Motor Needs a Transistor (2025 Q9(c) marking instructions): © Qualifications Scotland (SQA). N5 Engineering Science 2023 Q9(d) and 2025 Q9(b)(c), question papers and marking instructions.

Model Answer: Complete the Wiring (2023 Q9(d) MI): © Qualifications Scotland (SQA). N5 Engineering Science 2023 Q9(d) and 2025 Q9(b)(c), question papers and marking instructions.

The Same Circuit in the Simulator: NoSyntaxSim V2 screenshot (hardware panel). Simulator by Peter Strain, NoStrainSims (sites.google.com/view/nostrainsim), free and open to all.

Spot the Mistake (2023 Q9(d) MI): © Qualifications Scotland (SQA). N5 Engineering Science 2023 Q9(d) and 2025 Q9(b)(c), question papers and marking instructions.

Credits (4 of 4)

Past Papers: Wiring: © Qualifications Scotland (SQA). N5 Engineering Science 2023 Q9(d), question paper and marking instructions.

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

R Stewart - October 2026