

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	



General Certificate of Secondary Education
June 2014

Design & Technology: Systems & Control Technology

45651

Unit 1 Written Paper

Friday 23 May 2014 1.30 pm to 3.30 pm

For this paper you must have:

- a black pen, a pencil, a ruler, an eraser and a pencil sharpener.

You may use a calculator.

Time allowed

- 2 hours

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this answer book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- The questions in Section A relate to the context referred to in the Preliminary Material that was previously issued.
- You are reminded of the need for good English and clear presentation in your answers. Quality of Written Communication will be assessed in Question 6(f).



J U N 1 4 4 5 6 5 1 0 1

You may need to use one or more of the following formulae when answering questions which include calculations.

Potential Difference $V = I \times R$

Series Resistance $R_T = R_1 + R_2$

Potential Divider Voltage 1 = $\frac{R_1}{R_1 + R_2}$ x Supply Voltage

Voltage 2 = $\frac{R_2}{R_1 + R_2}$ x Supply Voltage

Ratio of Simple Gears Gear ratio = $\frac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driver gear}}$

Velocity Ratio Velocity ratio = $\frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$

Output speed = $\frac{\text{Input speed}}{\text{Gear/Velocity ratio}}$

Mechanical Advantage $MA = \text{Load} / \text{Effort}$



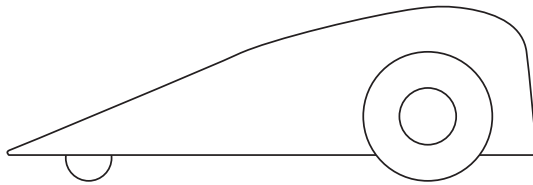
Section A

Answer **all** questions in the spaces provided.

You are advised to spend about 15 minutes on this question.

- 1** This question is about designing an educational robot for use in a primary school.

A manufacturing company has asked you to design a robot that can follow a black line on a white surface.



- 1 (a)** Before you begin to design the robot, a number of issues need to be considered.

Complete the table below by giving a power supply specification point and an aesthetic specification point. In each case you should justify why it is important.

An example has been completed for you.

[4 marks]

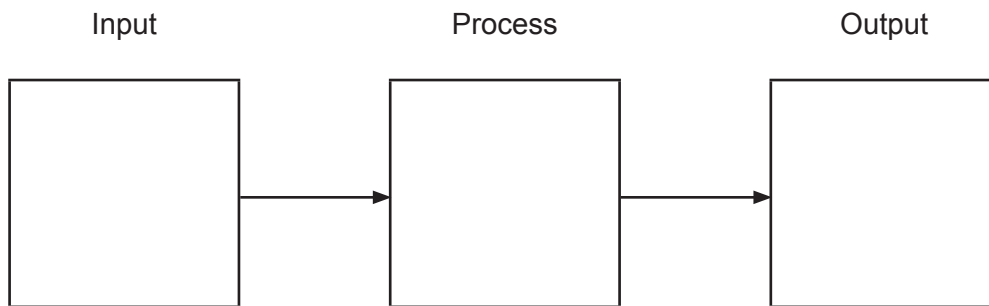
	<u>Functional specification point</u>	<u>Justification</u>
Example	The robot must follow a line	To demonstrate it is able to follow a set route
1	<u>Power supply specification point</u>	<u>Justification</u>
2	<u>Aesthetic specification point</u>	<u>Justification</u>

Turn over ▶



- 1 (b)** Name the main component in each stage of the system block diagram shown below for a line following robot.

[3 marks]



- 1 (c)** Using notes **and** sketches show how the robot's systems would work.

Marks will be awarded for:

- naming the correct component(s)
- the quality of sketching
- an explanation of the system.

- 1 (c) (i)** How the robot can sense the line.

[3 marks]



1 (c) (ii) How the robot can move.

[3 marks]

1 (c) (iii) How the robot can turn.

[3 marks]



You are advised to spend about 15 minutes on this question.

2 This question is about feedback.

2 (a) Control systems often use feedback.

Explain what feedback is.

[2 marks]

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2 (b) Feedback can be both an advantage and a disadvantage.

2 (b) (i) Give an example of where feedback is an advantage.

[2 marks]

.....

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.....

2 (b) (ii) Give an example of where feedback is a disadvantage.

[2 marks]

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2 (c) Explain how designers can use feedback to control a robot following a line.

[3 marks]

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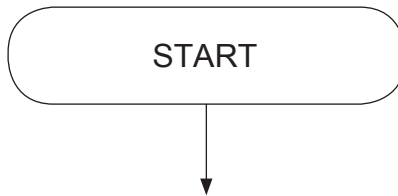
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2 (d) Draw a flowchart to show how the robot you have designed follows the edge of a black line.

[6 marks]



Section B

Answer **all** questions in the spaces provided.

You are advised to spend about 15 minutes on this question.

3 This question is about identifying components and their use.





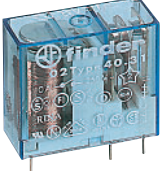

3 (a) In the table below, give the component name and the electronic building block it would be used for. The electronic building block will be one of the following:

INPUT

PROCESS

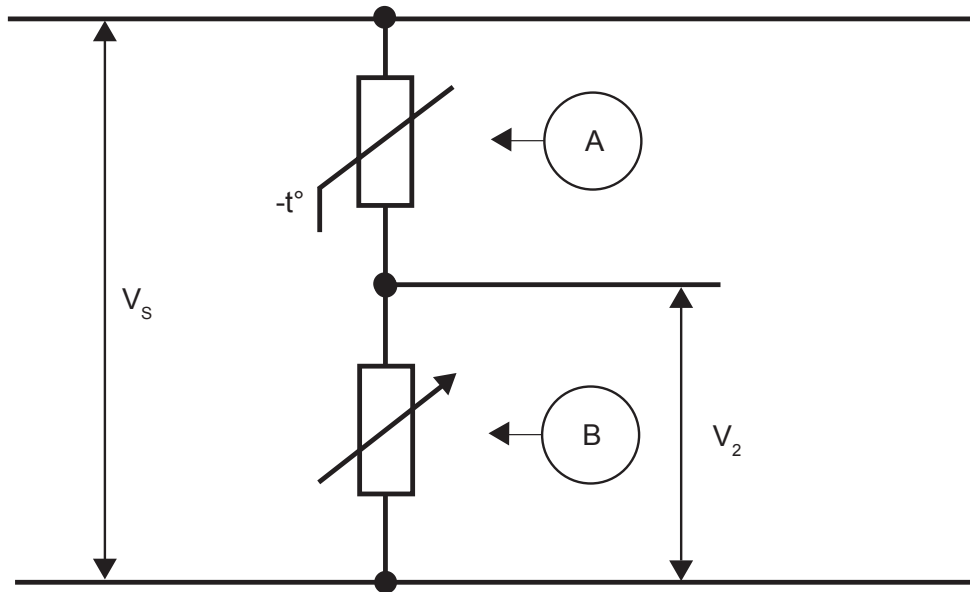
OUTPUT

[10 marks]

No.	Component image	Component name	Electronic building block
1			
2		Transistor	
3			
4			
5			Process
6			



3 (b) The circuit below is for a heat sensor.



3 (b) (i) Name component A.

[1 mark]

.....

3 (b) (ii) Name component B.

[1 mark]

.....

3 (c) The resistance of component A is $10\text{k}\Omega$ and the resistance of component B is $20\text{k}\Omega$.

Calculate the output voltage (V_2) when the supply voltage (V_s) is 9 volts.

[4 marks]

Formula.....

.....

Calculation

.....

.....

.....

Answer

Turn over ▶



You are advised to spend about 25 minutes on this question.

- 4 This question is about programming a barrier for a model railway crossing.



The model barrier system has:

- a sensor that detects a model train
- a barrier that lifts
- a light that flashes before the barrier lifts
- a switch that is operated when the barrier is up.

- 4 (a) (i) Name a suitable material for the model barrier.

[1 mark]

.....

- 4 (a) (ii) Explain why the material that you have named is suitable.

[2 marks]

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4 (b) (i) Name a suitable component to sense a model train.

[1 mark]

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4 (b) (ii) Describe how your system senses a model train.

[2 marks]

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4 (b) (iii) Sketch on the diagram below how the component you have named in part 4(b)(i) senses a model train.

Marks will be awarded for:

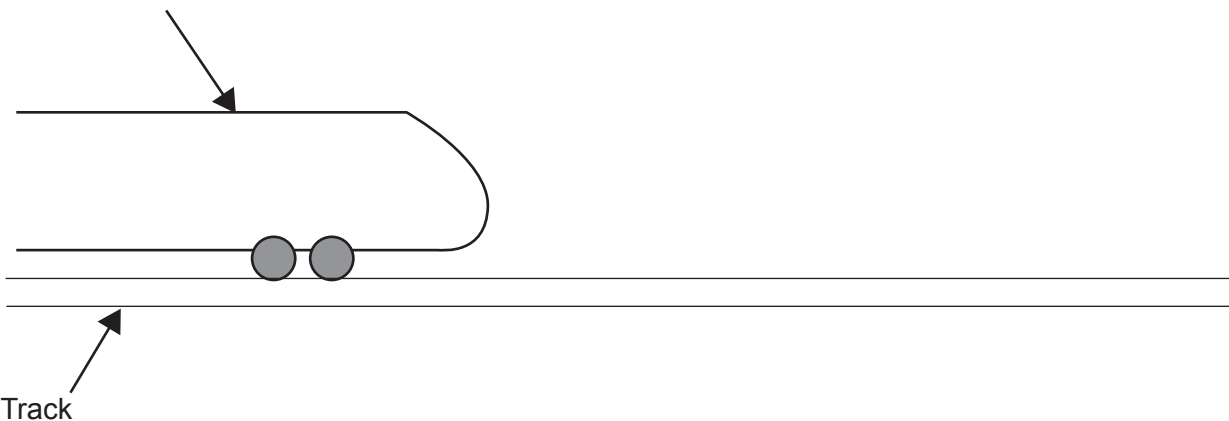
- the component mounted correctly
- the ability to sense a model train
- a good quality labelled sketch of the component.

[1 mark]

[1 mark]

[2 marks]

Model train



Turn over ▶



4 (c) The operation of the model barrier system is as follows:

- the barrier goes down when a train is approaching
- the barrier takes 5 seconds to go down by powering the motor DOWN
- the barrier goes UP 30 seconds after going DOWN
- to make the barrier go UP the motor powers UP until fully UP
- a switch detects when the barrier is fully up
- this process is continuous (non-stop).

Complete the flowchart of the program for the micro controller on the opposite page.

- Add the following statements to the correct process boxes

[6 marks]

- Motor OFF
- Motor OFF
- Motor UP
- Motor DOWN
- Wait 5 Seconds
- Wait 30 Seconds

- Add each correct connecting line. There are 3 missing lines.

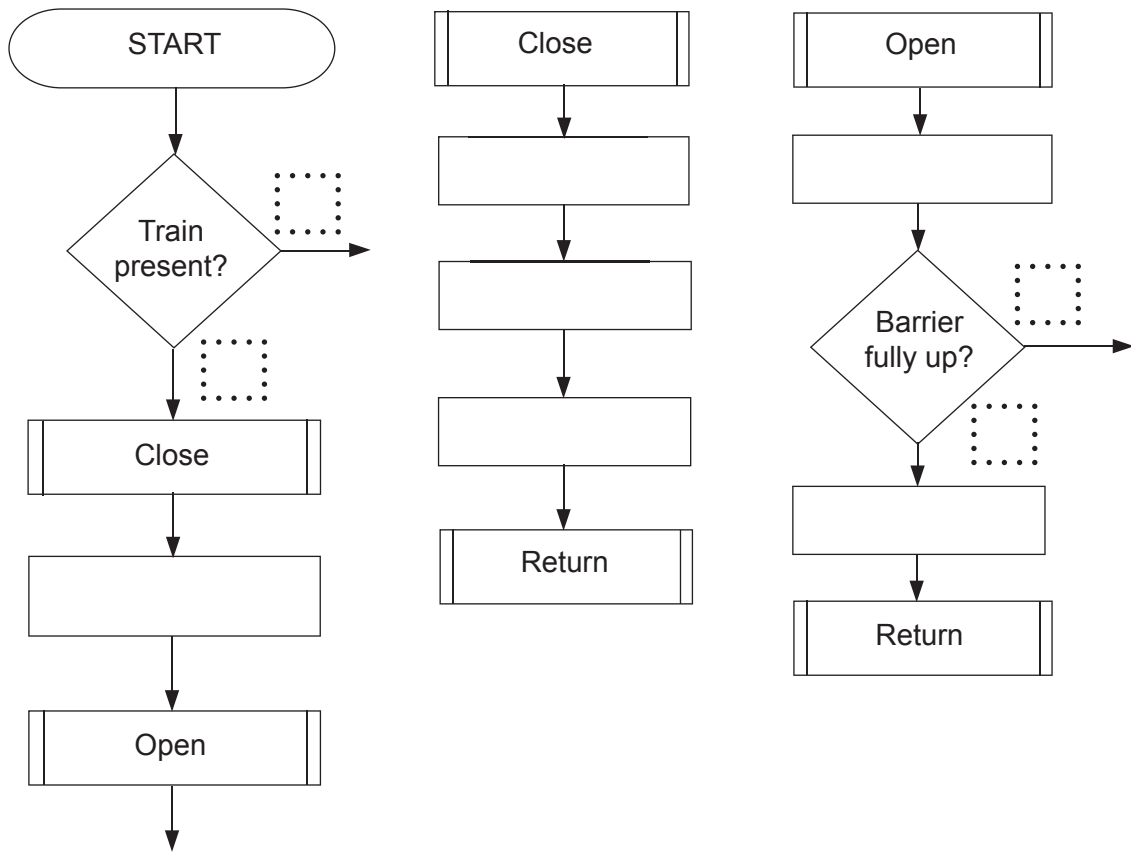
[3 marks]

- Add each correct output state of the decision boxes.
Use 1 for Yes and 0 for No.

Example Yes = $\begin{array}{c} \cdot \cdot \cdot \cdot \\ \cdot \cdot 1 \cdot \\ \cdot \cdot \cdot \cdot \end{array}$ No = $\begin{array}{c} \cdot \cdot \cdot \cdot \\ \cdot \cdot 0 \cdot \\ \cdot \cdot \cdot \cdot \end{array}$

[4 marks]





Turn over for the next question

Turn over ▶



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ANSWER IN THE SPACES PROVIDED**



You are advised to spend about 20 minutes on this question.

5 This question is about Printed Circuit Board (PCB) construction.

5 (a) Describe **one** method of testing a circuit **before** building a PCB. **[3 marks]**

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5 (b) Explain **two** advantages of using Computer Aided Design (CAD) to design PCBs. **[4 marks]**

Advantage 1

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Advantage 2

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5 (c) List **five** main stages in a PCB production process. **[5 marks]**

1.....

2.....

3.....

4.....

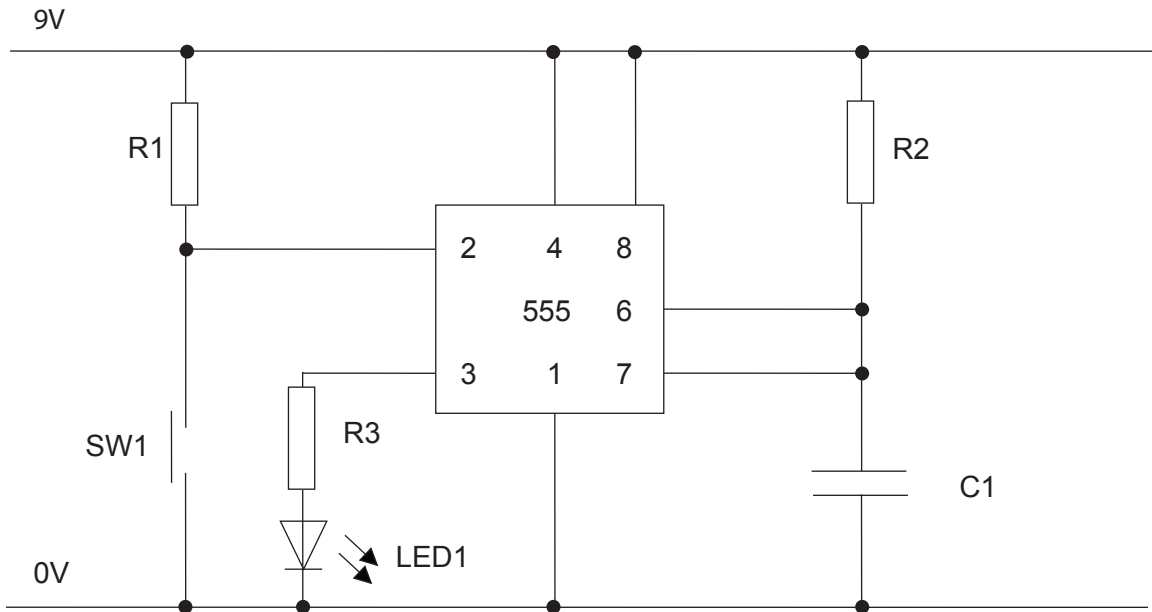
5.....

Turn over ▶



5 (d) The circuit below controls the LED output.

Figure 1



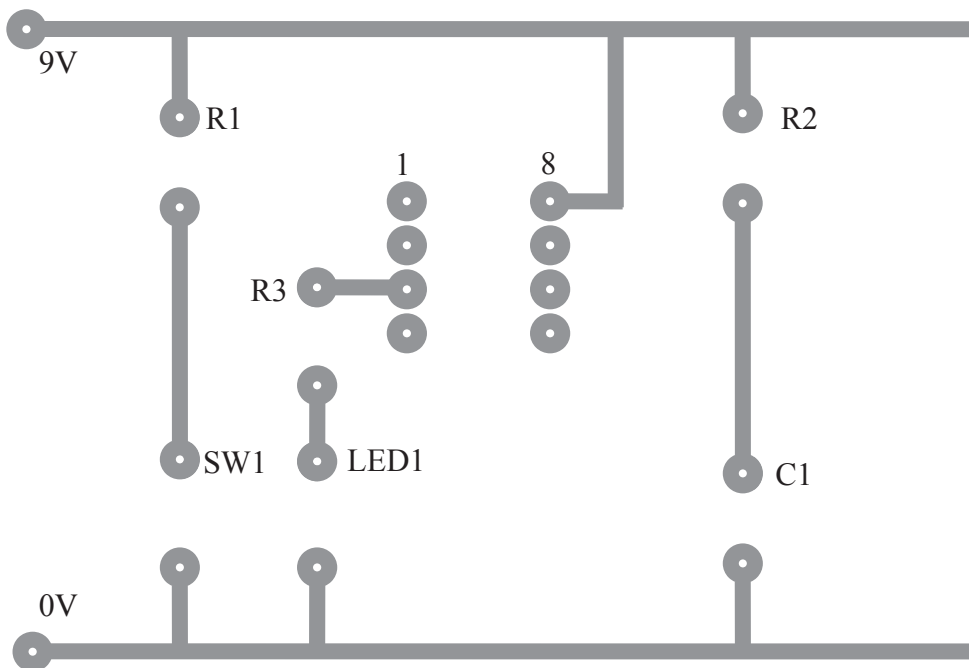
Complete the missing **five** PCB tracks on **Figure 2** for the circuit in **Figure 1**.

Do not let tracks cross.

The pads and some of the tracks have been completed for you.

[5 marks]

Figure 2



5 (e) Describe **one** method of testing a PCB **after** it is completed.

[3 marks]

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20

Turn over for next question

Turn over ▶



You are advised to spend about 30 minutes on this question.

6 This question is about vending machine systems.

The table below shows a system in an educational model that dispenses a chocolate bar if the customer inserts three coins in three slots.

	State	Output
Micro switch	Coin present	1
	No coin present	0
Dispense chocolate bar	YES	1
	NO	0



Coins



Coin Slots

In this system:

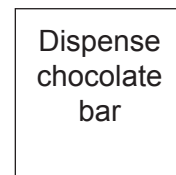
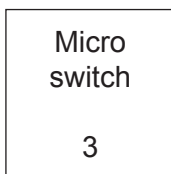
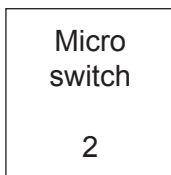
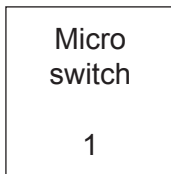
- there is a micro switch in each coin slot
- the system should dispense a chocolate bar when all three slots hold one coin each.



6 (a) Using **two** input logic gates, construct a logic circuit in the space below to join the three micro switches to the 'Dispense chocolate bar' block to give the required output.

Marks will be awarded for:

- logic gates symbols [2 marks]
- inputs to gates [4 marks]
- output to dispensing system [1 mark]
- quality of drawing. [1 mark]



6 (b) (i) State the type of motion that the output of a solenoid gives. [1 mark]

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6 (b) (ii) State **one** advantage of using a solenoid in a system. [2 marks]

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Turn over ▶



6 (b) (iii) State **one** disadvantage of using a solenoid in a system.

[2 marks]

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6 (c) Vending machines often have a system to sense if the user is tipping the machine.

Name a component that could sense that the user is tipping the machine.

[1 mark]

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6 (d) Vending machines often need to use a delay in their processes.

For example, they may need to use a delay so that a cup can fill or a snack can fall.

State **two** methods for delaying the process.

Name the specific components used.

[4 marks]

Method 1

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Method 2

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6 (e) Health and safety is very important when providing systems for the general public to use.

Give **two** health and safety issues to consider in the design specification of a vending machine.

Example – The system should not fall on the user if the user tips it.

[4 marks]

Issue 1

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Issue 2

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Question 6 continues on the next page

Turn over ▶



6 (f) Users can topple vending machines onto themselves and be injured or killed.

Discuss who is responsible for this type of accident and give examples of how manufacturers can design safety into a vending machine.

You will be tested for Quality of Written Communication in this part of the question.

[8 marks]

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END OF QUESTIONS

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