

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	



General Certificate of Secondary Education
June 2015

Design and Technology: Systems and Control Technology

45651

Unit 1 Written Paper

Tuesday 19 May 2015 9.00 am to 11.00 am

For this paper you must have:

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

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.
- Section A relates to the context given 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(b).
- You may use a calculator.



J U N 1 5 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 30 minutes on this question.

- 1** This question is about designing a river water level warning device.

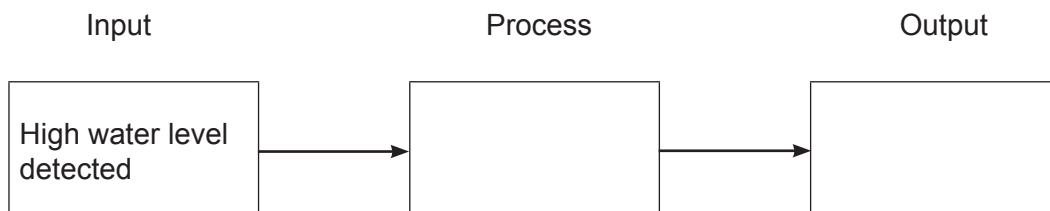
Many homeowners have experienced flooding.

A company has asked you to design a system that would monitor the level of water in a river. The system should give a warning when there is a risk of flooding.



- 1 (a)** Complete the block diagram below to explain each stage of the water level warning system.

[2 marks]



Turn over ▶



1 (b) Name two suitable input **components** for the water level warning system.

Give a suitable design advantage for each.

[6 marks]

Input component 1

Advantage of input component 1.....

.....

.....

.....

.....

Input component 2

Advantage of input component 2

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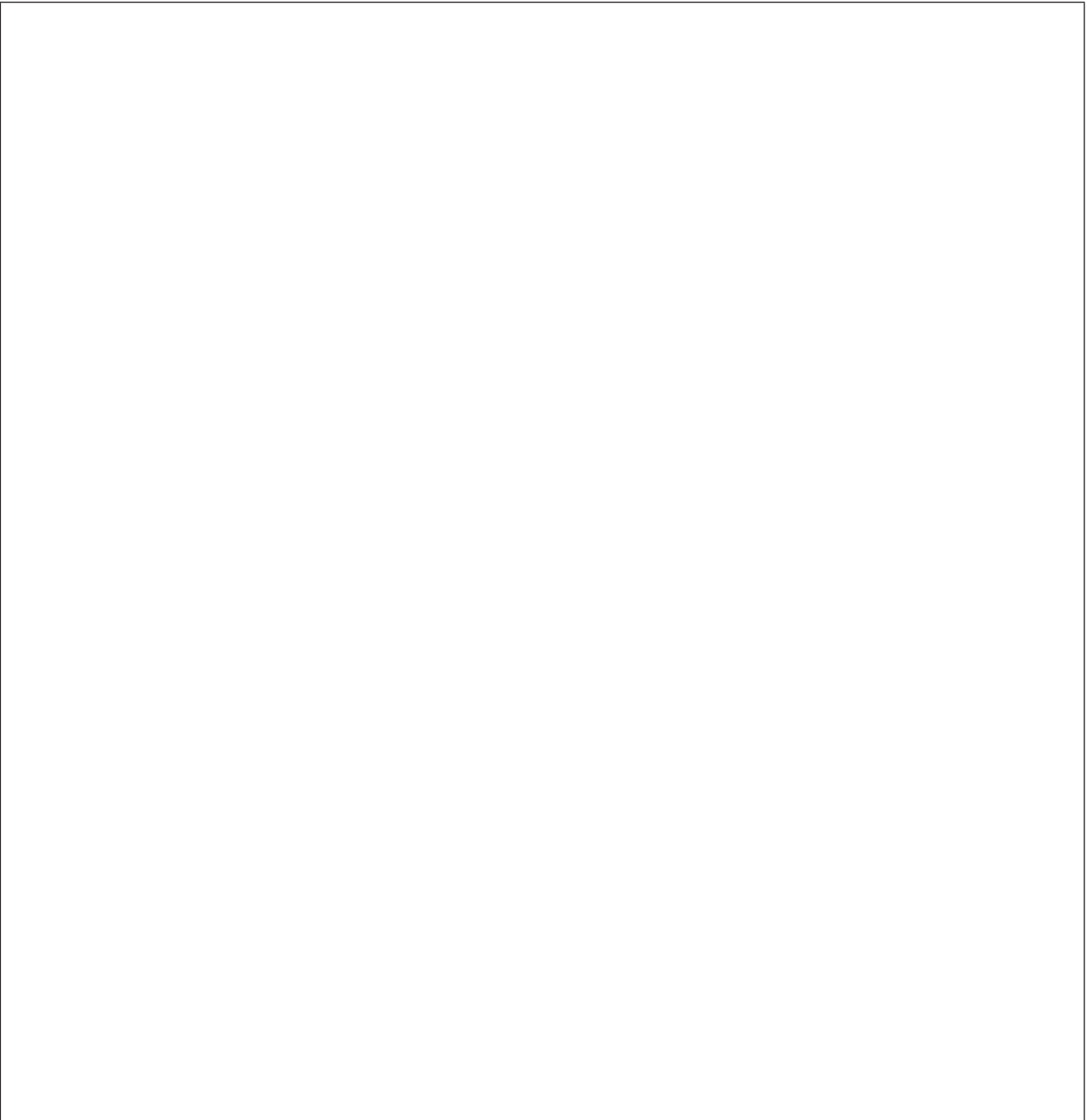
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1 (c) In the box below use notes and sketches to design a product that meets each of the following criteria:

- it will warn the user when a set water level is reached. **[2 marks]**
- it can be adjusted or set for different water levels **[3 marks]**
- the product is suitable for use outdoors **[3 marks]**
- there is a method of switching on and off **[2 marks]**
- the product is visually appealing. **[3 marks]**



Turn over ▶



1 (d) In the space below evaluate your design against the criteria given in part (c).

[4 marks]

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1 (e) (i) The case for the product is to be produced as a **one-off**.

State a suitable material and manufacturing process. Give reasons for your choices.

[4 marks]

Material

Process

Reasons.....

.....

.....

1 (e) (ii) The manufacturing of the case for the product is to be in a **batch** of 5000.

State a suitable material and manufacturing process. Give reasons for your choices.

[4 marks]

Material

Process

Reasons.....

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Section B

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

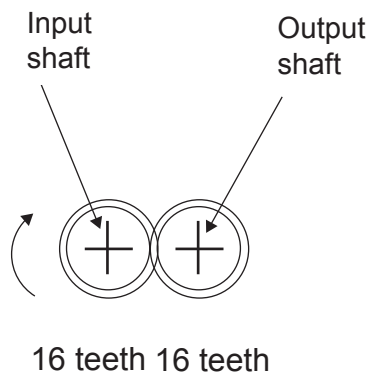
You are advised to spend about 10 minutes on this question.

2 This question is about mechanical systems.

2 (a) In each of the following cases, state the direction of travel and the speed of the output shaft.

2 (a) (i) Simple Gear Train - the input shaft is rotating clockwise at 1000 rpm.

[2 marks]



Output shaft direction.....

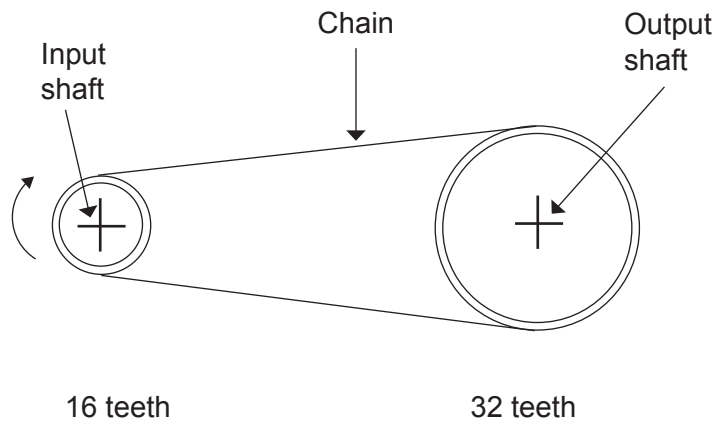
Output shaft speed

Turn over ▶



2 (a) (ii) Chain and Sprocket - the input shaft is rotating clockwise at 1000 rpm.

[2 marks]



Output shaft direction

Output shaft speed



2 (b) (i) Explain why friction can be a disadvantage in mechanical systems.

[3 marks]

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2 (b) (ii) Explain how friction can be reduced in mechanical systems.

[3 marks]

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10

Turn over for the next question

Turn over ▶



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**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**



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

3 This question is about electro-mechanical systems.

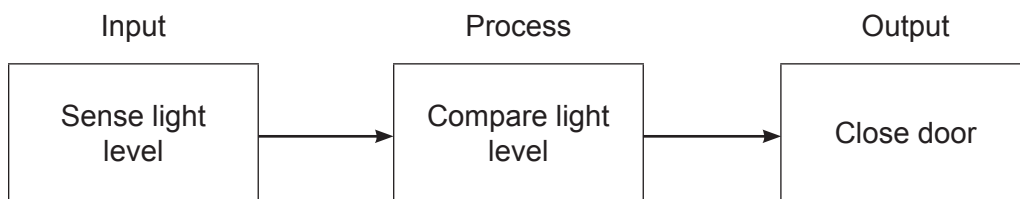
The entrance to a hen house has a vertically sliding door.

A farmer wants the door of the hen house to close and lock automatically at night.



3 (a) Using the block diagram below, name suitable components for each stage of the door closing system.

[3 marks]



Input component

Process component

Output component

3 (b) Select the type of motion displayed by the door when it closes.

[1 mark]

Rotary

Oscillating

Linear

Reciprocating

Turn over ▶



- 3 (c)** On the diagram below draw and label a mechanical system that could both raise and lower the door by 300 mm.

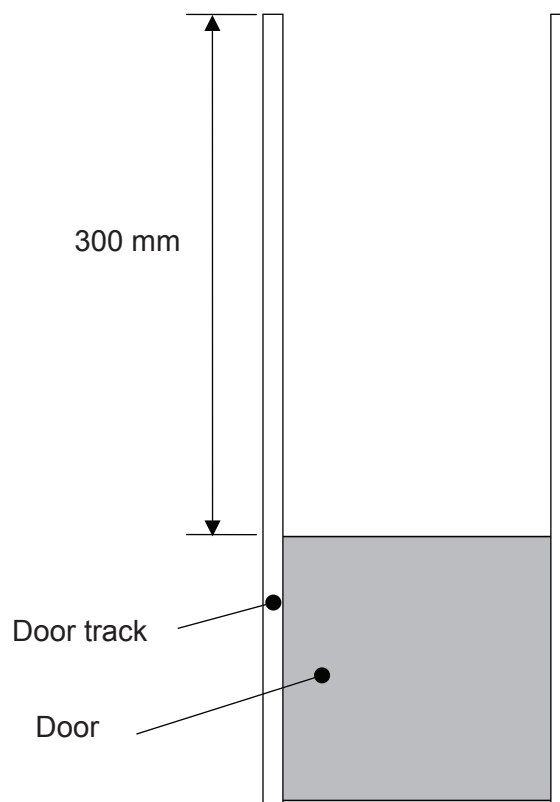
[4 marks]

Please note the door is shown in the lower position.

Marks will be awarded for:

- naming the correct component(s)
- the quality of communication
- an explanation of how the system operates.

Door Raising and Lowering System

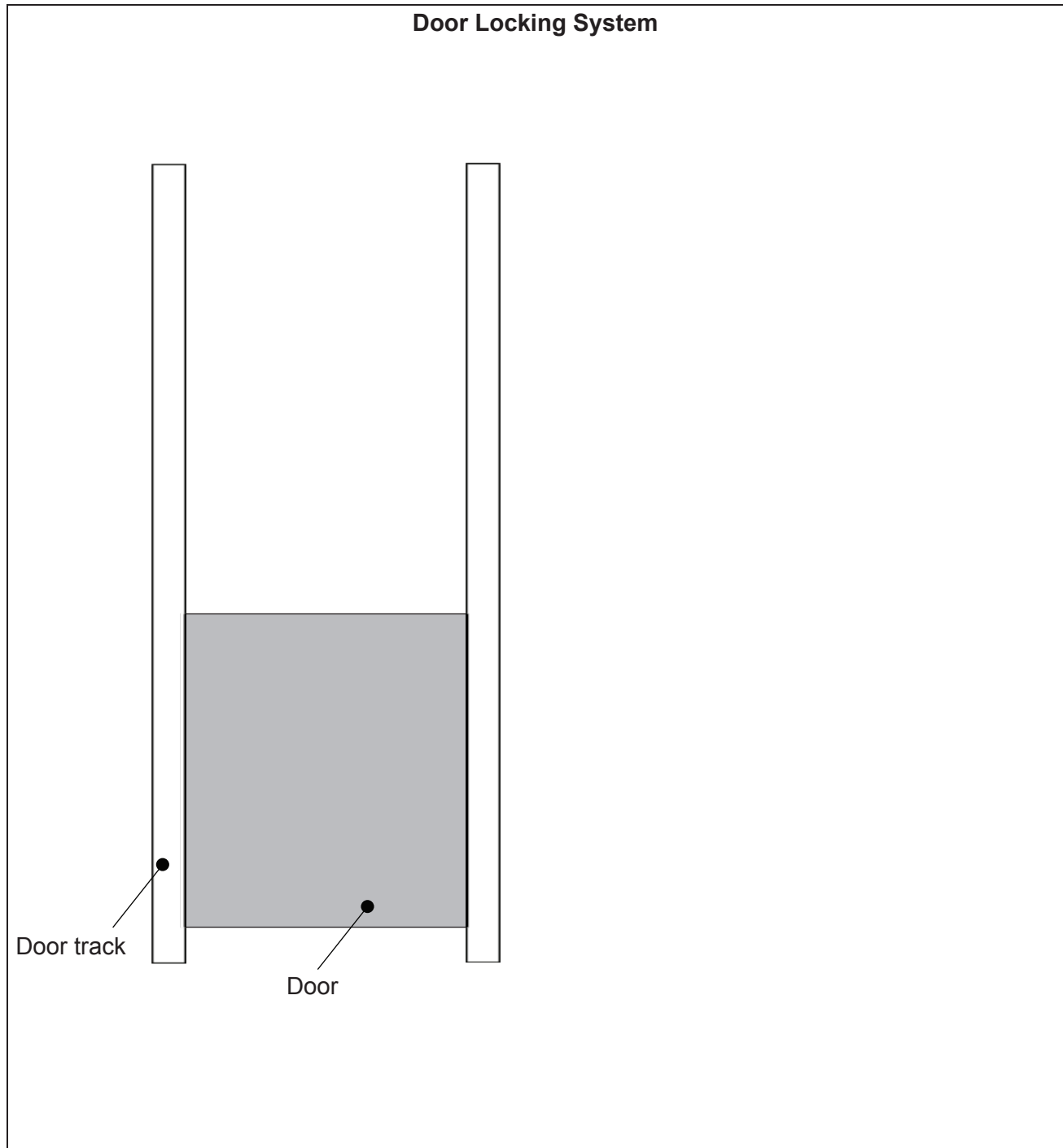


- 3 (d)** On the diagram below draw and label a system or component that is different to the one you have used in part 3 (c). This should lock the door closed when the system senses that it is dark.

[4 marks]

Marks will be awarded for:

- naming the correct component(s)
- the quality of communication
- the ability to lock
- an explanation of how the system operates.



Turn over ▶



3 (e) It has been decided to fully automate the control of the hen house door.

A microcontroller based system will be used.

The operation of the hen house door system is as follows:

- the hen house door goes down when it gets dark
- the hen house door takes 10 seconds to go down by powering the motor DOWN
- once down, the door locks
- when it is light, the door unlocks and goes UP
- to make the door go UP the motor powers UP until fully UP
- a sensor detects when the door is fully UP
- this process is continuous.

Complete the flowchart of the program for the microcontroller on the opposite page by adding:

- the following statements to the correct process boxes

[7 marks]

- Motor OFF
- Motor OFF
- Motor UP
- Motor DOWN
- Door Lock
- Door Unlock
- Wait 10 Seconds

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

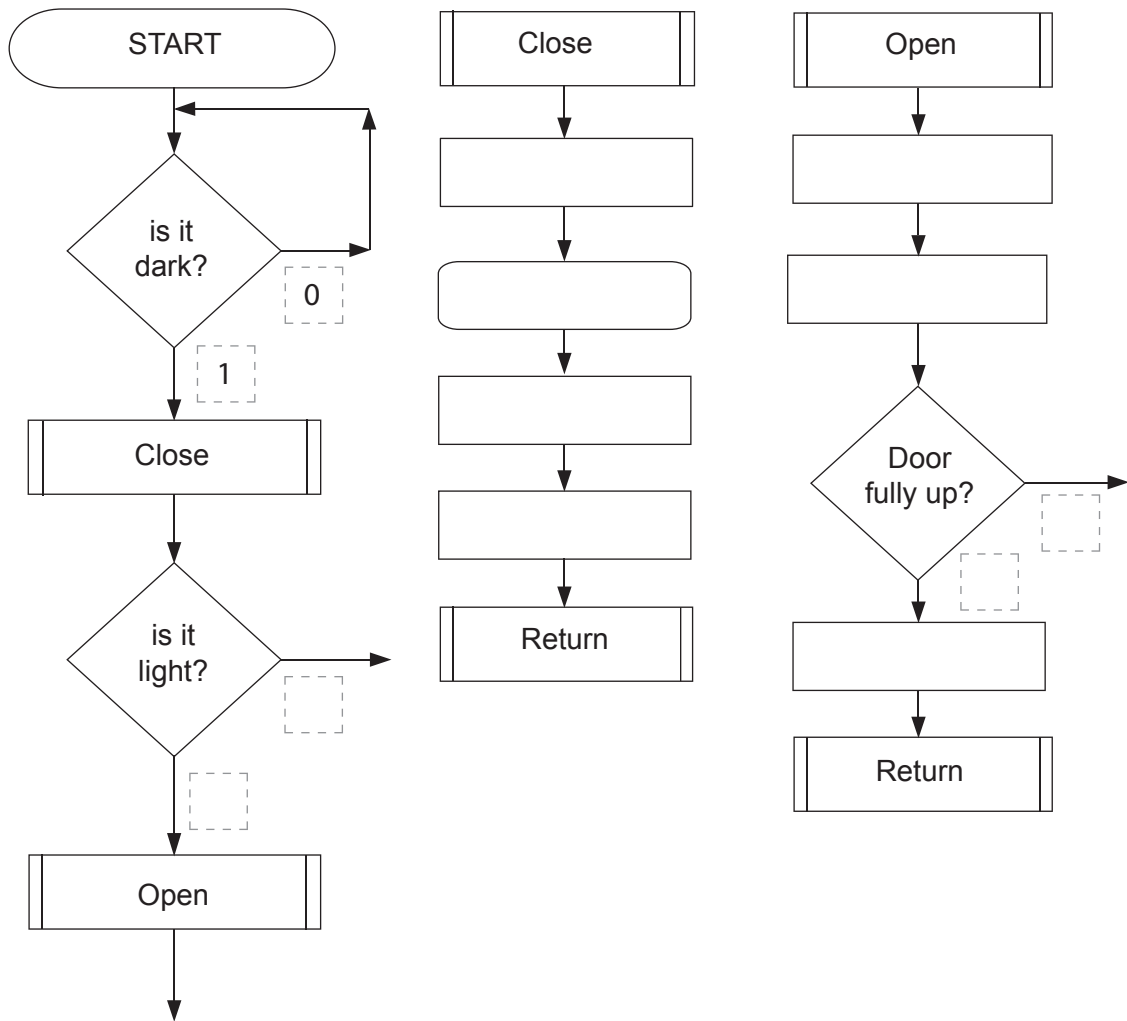
[4 marks]

Example Yes = No =

- the missing lines.

[3 marks]





3 (f) The hen house is in a field with no mains electricity.

Suggest a renewable energy source that could close the hen house door and explain why this energy source is suitable.

[3 marks]

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You are advised to spend about 5 minutes on this question.

- 4 A gardener wants an automatic system that will oscillate a lawn sprinkler.

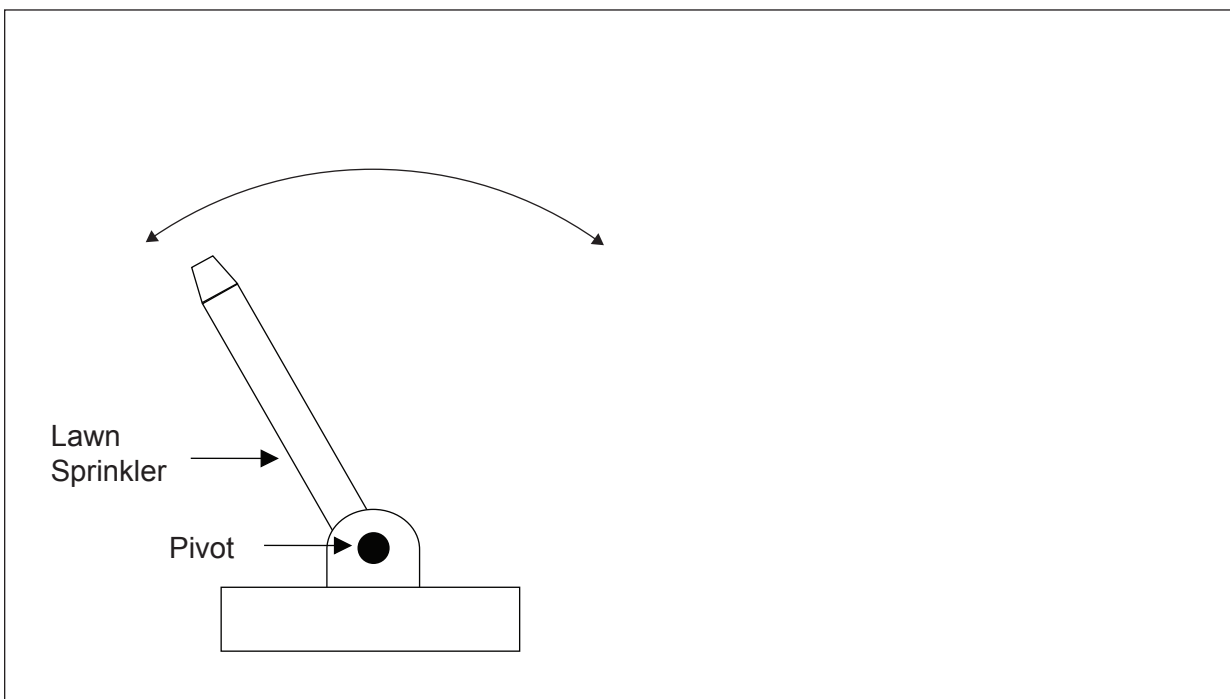


On the diagram below draw and label a mechanical system which could oscillate the lawn sprinkler.

[4 marks]

Marks will be awarded for:

- naming the correct component(s)
- continuous operation
- the quality of communication
- an explanation of the system.



4

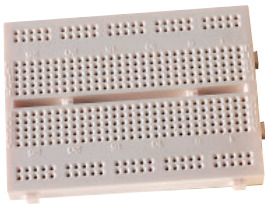
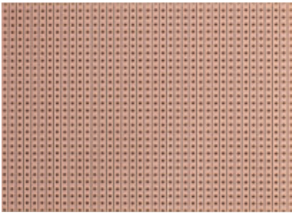
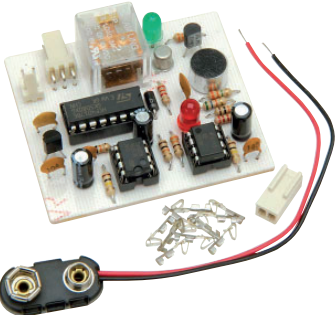


You are advised to spend about 10 minutes on this question.

5 This question is about prototyping circuits.

5 (a) Give an advantage and disadvantage for each of the following circuit construction techniques. Do not repeat any of your responses.

[6 marks]

	Advantage	Disadvantage
 Prototyping Board (Breadboard)
 Copper Strip Board (Veroboard)
 Printed Circuit Board

Turn over ▶



5 (b) Give **two advantages** of modelling circuit designs on a computer instead of building them.

[2 marks]

Advantage 1

.....
.....

Advantage 2

.....
.....

5 (c) Give **two disadvantages** of modelling circuit designs on a computer instead of building them.

[2 marks]

Disadvantage 1

.....
.....

Disadvantage 2

.....
.....

10

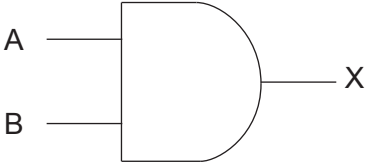


You are advised to spend about 25 minutes on this question.

7 This question is about logic.

7 (a) Complete the following table.

[10 marks]

Symbol	Type of Gate	Truth Table															
 <p>A ———— B ————</p> <p style="text-align: right;">X</p>		<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td></td> </tr> <tr> <td>1</td> <td>0</td> <td></td> </tr> <tr> <td>1</td> <td>1</td> <td></td> </tr> </tbody> </table>	A	B	X	0	0	0	0	1		1	0		1	1	
A	B	X															
0	0	0															
0	1																
1	0																
1	1																
<p>A ————</p> <p style="text-align: right;">X</p>	NOT	<table border="1"> <thead> <tr> <th>A</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td></td> </tr> </tbody> </table>	A	X	0	1	1										
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A	B	X															
0	0																
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7 (b) Front seat car passengers are protected by air bags in the event of a crash.

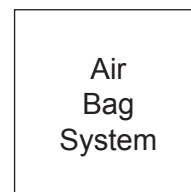
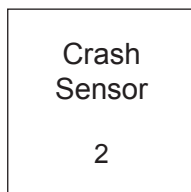
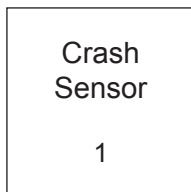
In a car the air bag should only activate when there is no baby seat on the front seat **and** either of the crash sensors is activated.

Input	State	Output
Crash Sensor 1	Impact detected	1
	No Impact	0
Crash Sensor 2	Impact detected	1
	No Impact	0
Front Seat Baby Seat Switch	Baby seat present	1
	No baby seat	0

The air bag system should receive a **high** signal when either of the crash sensors has been activated and there is no baby seat on the front seat.

Complete a logic circuit diagram to operate a car safety air bag.

[8 marks]



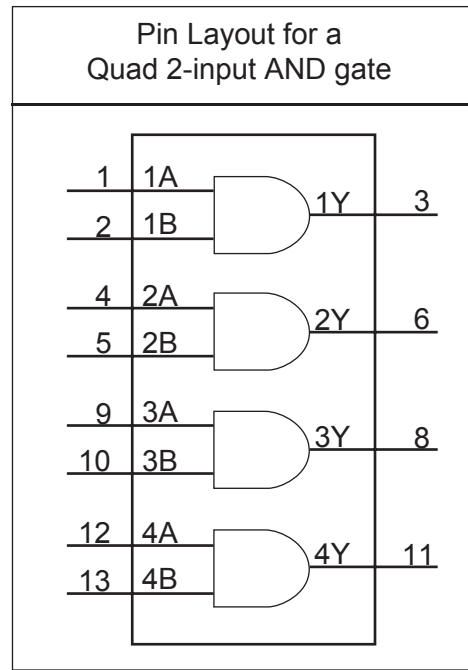
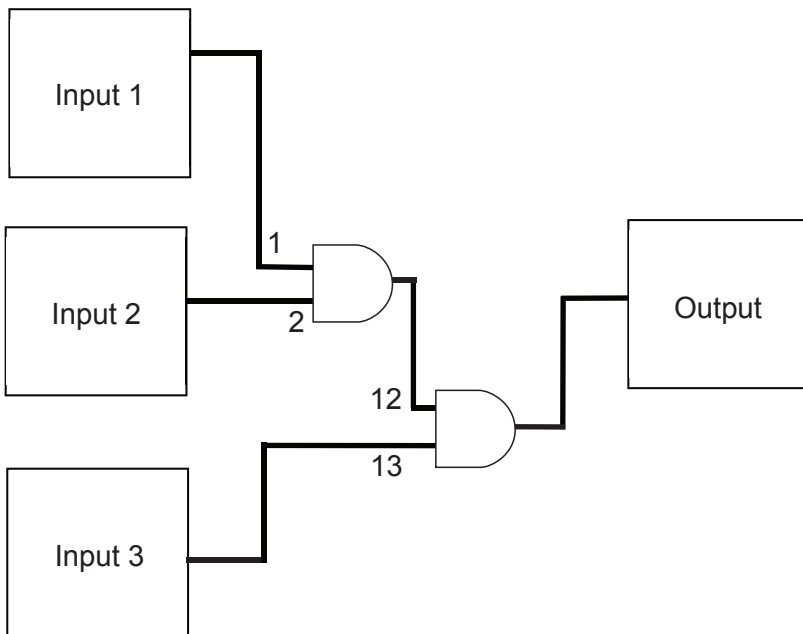
Turn over ▶



7 (c) A printed circuit board (PCB) is required for a safety circuit.

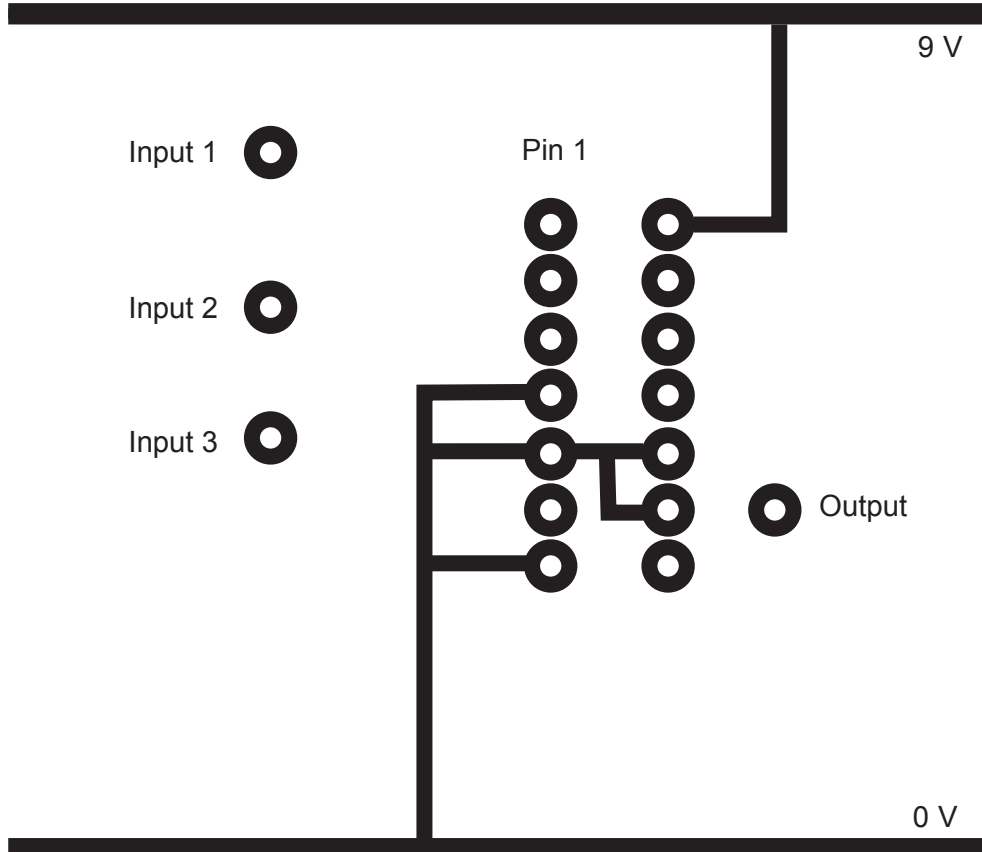
An incomplete schematic diagram of the logic layout is shown below and also a pin layout of the logic chip.

[6 marks]



Complete the PCB layout for the logic circuit below using the information provided on page 22.

Please note that the PCB Layout is viewed from the component side.



END OF QUESTIONS



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