

FOR OFFICIAL USE

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	KU	RNA
Total Marks		

# 4040/402

NATIONAL  
QUALIFICATIONS  
2010

TUESDAY, 4 MAY  
2.35 PM – 4.05 PM

TECHNOLOGICAL  
STUDIES  
STANDARD GRADE  
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

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Scottish candidate number

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Number of seat

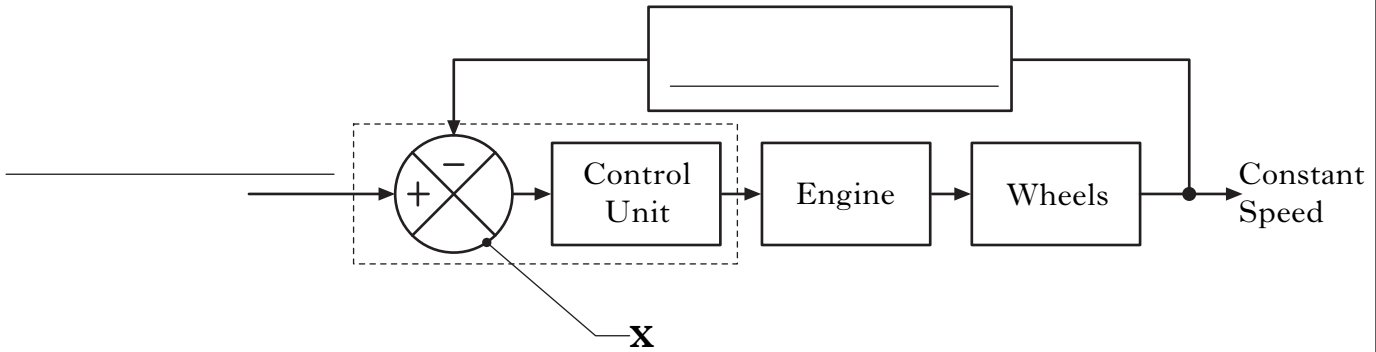
- 1 Answer all the questions.
- 2 Read every question carefully before you answer.
- 3 Write your answers in the spaces provided.
- 4 Do **not** write in the margins.
- 5 Do **not** sketch in ink.
- 6 All dimensions are given in millimetres.
- 7 **Show all working and units where appropriate.**
- 8 Reference should be made to the Standard Grade and Intermediate 2 Data Booklet (2008 edition) which is provided.
- 9 Before leaving the examination room you must give this book to the Invigilator. If you do not, you may lose all the marks for this paper.



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1. A manufacturer wants to use a cruise control system to keep a car's speed constant even when it goes up and down hills. The system should allow a driver to take their foot off the accelerator once the desired speed has been set.

(a) Complete the **control** diagram below for the cruise control system.



(b) State the name of the control diagram symbol **X**.

\_\_\_\_\_

(c) This control system makes use of a feedback loop. State the type of control produced by this automatic system.

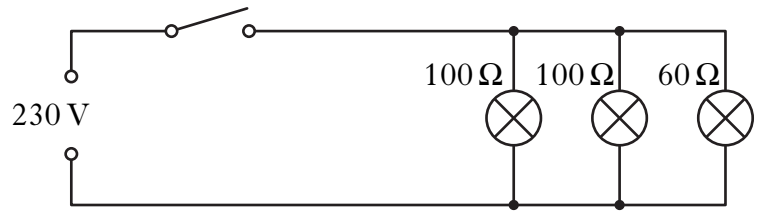
\_\_\_\_\_

2  
1  
0

1  
0

1  
0

2. An interior designer wants three lamps to come on when a switch is activated. The lighting circuit is shown below.



(a) State two reasons why it is good practice to have the lamps wired in **parallel** rather than in series.

(i) \_\_\_\_\_

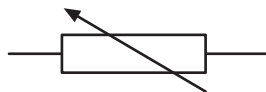
(ii) \_\_\_\_\_

(b) Calculate, showing all working and units, the total resistance of the lighting circuit shown above.

2  
1  
0

2  
1  
0

The designer wants the brightness of the lights to be altered using the following component.



(c) State the name of the component shown above.

\_\_\_\_\_

1  
0

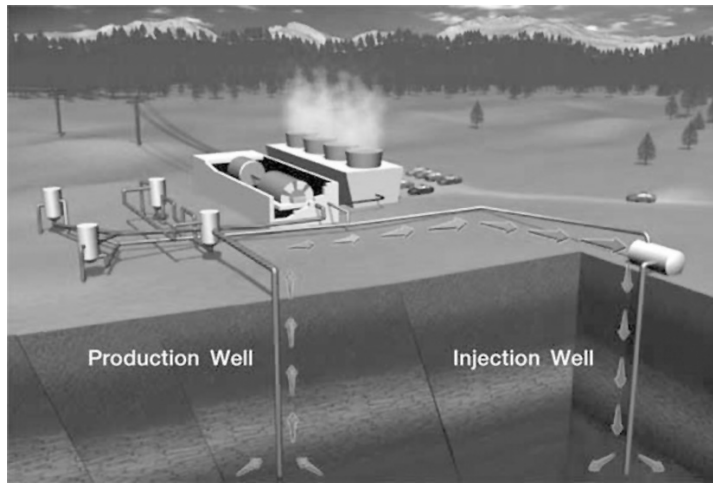
(d) State the name of the device that is used to measure current in a circuit.

\_\_\_\_\_

1  
0

[Turn over

3. A geothermal power plant uses the heat in the earth to help produce electricity.



(a) Calculate the heat energy absorbed by 100 litres of water which is pumped into the earth at  $10^{\circ}\text{C}$  and comes out as steam at  $240^{\circ}\text{C}$ . (1 litre of water has a mass of 1 kg.)

(b) For every 15 MJ of heat energy that comes from the ground, the power plant produces 5.34 MJ of electricity.

(i) Calculate the efficiency of the power plant.

(ii) Explain why the power plant will not be 100% efficient.

3  
2  
1  
0

2  
1  
0

1  
0

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**3. (continued)**

(c) Geothermal is a source of renewable energy. State two **other** examples of a renewable energy source.

1 \_\_\_\_\_

2 \_\_\_\_\_

2  
1  
0

(d) State two **disadvantages** of using fossil fuels, other than cost.

1 \_\_\_\_\_

2 \_\_\_\_\_

2  
1  
0

(e) State two ways that energy can be conserved in the home.

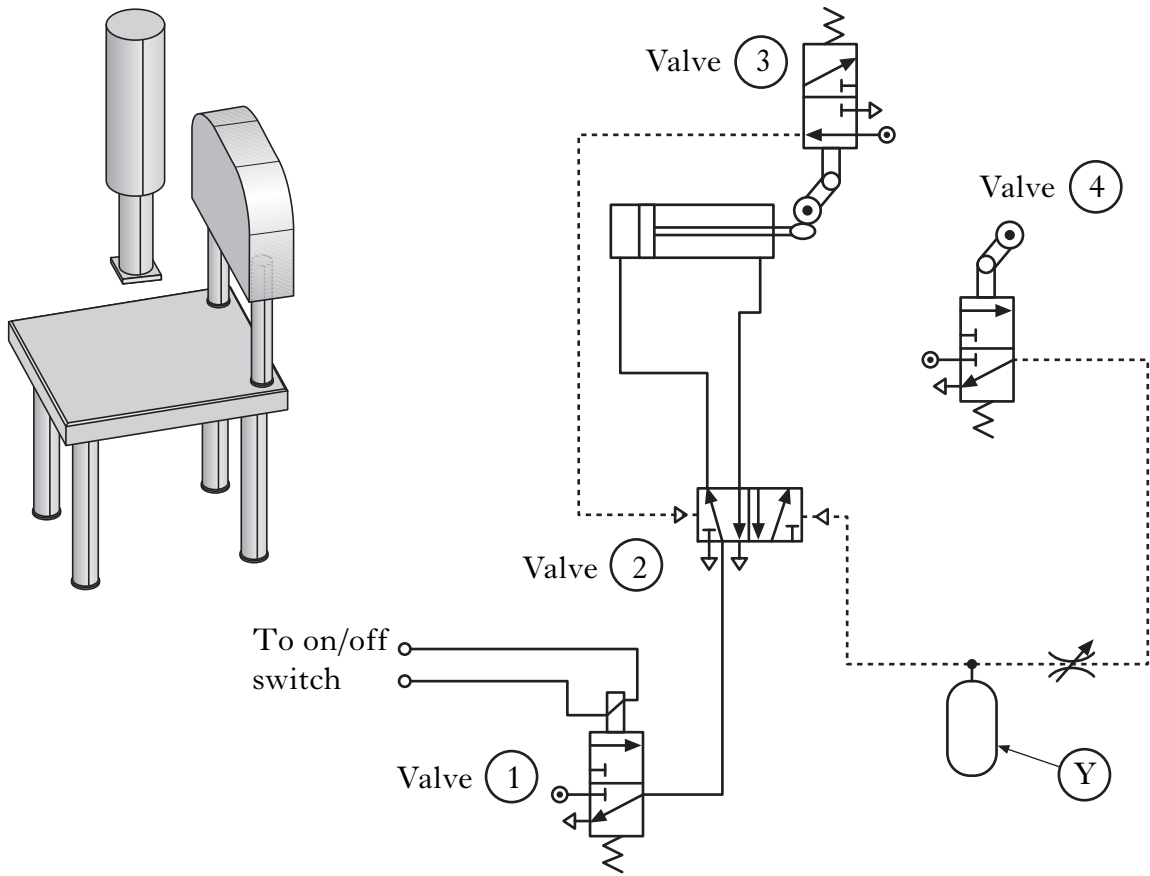
1 \_\_\_\_\_

2 \_\_\_\_\_

2  
1  
0

**[Turn over**

4. A test rig in a furniture factory is operated by the pneumatic circuit shown below.



(a) Describe, using appropriate terminology, how the pneumatic circuit operates.

*When Valve 1 is actuated*

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5  
4  
3  
2  
1  
0

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3	
2	
1	
0	
1	
0	
2	
1	
0	
1	
0	
2	
1	
0	

**4. (continued)**

(b) State the **full name** of the following components.

Valve (1) \_\_\_\_\_

Component (Y) \_\_\_\_\_

(c) State two ways to vary the length of a pneumatic time delay.

1 \_\_\_\_\_

2 \_\_\_\_\_

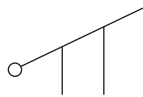
To reduce damage it was decided to slow the piston movement as it outstrokes. The piston should still instroke quickly.

(d) (i) State the **full name** of a pneumatic component that could be used to slow a piston in one direction.

\_\_\_\_\_

(ii) Mark (X) on the pneumatic circuit where this component should be inserted.

(e) State the name of the following pneumatic actuators.



\_\_\_\_\_



\_\_\_\_\_

**[Turn over**





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1 0	
1 0	

**5. (continued)**

(d) State the voltage at which a transistor saturates.

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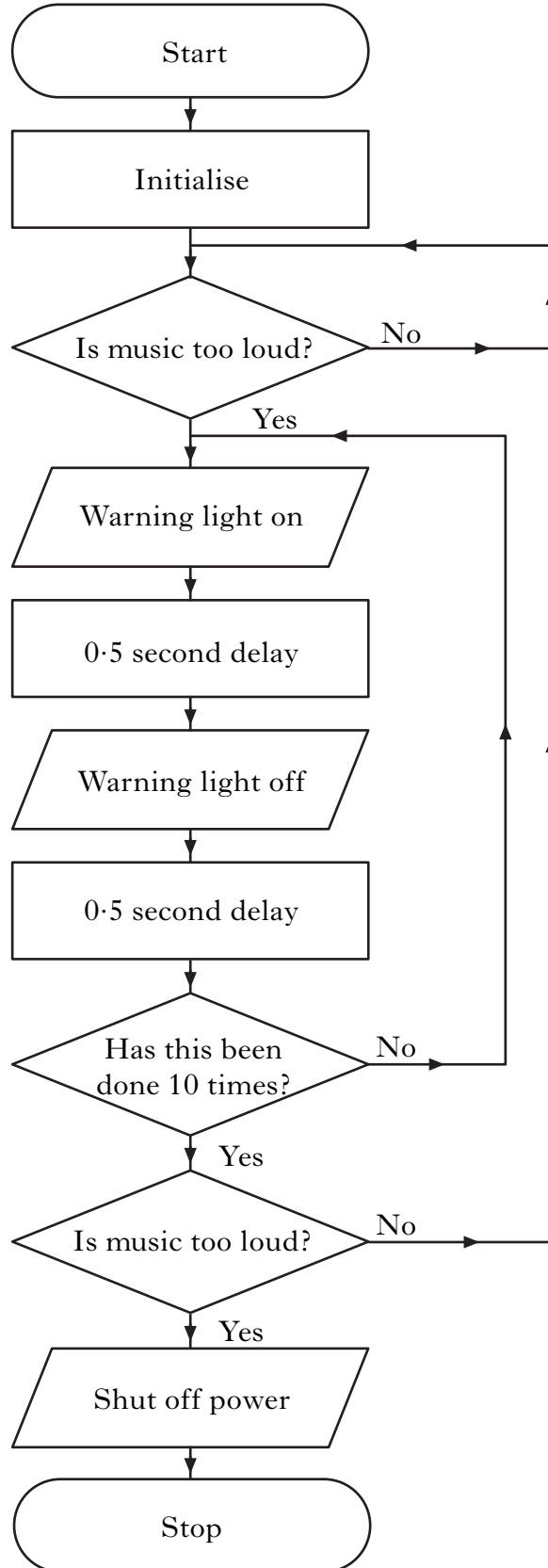
(e) A diode is normally wired in parallel across devices such as relays. State the purpose of the diode.

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**[Turn over**

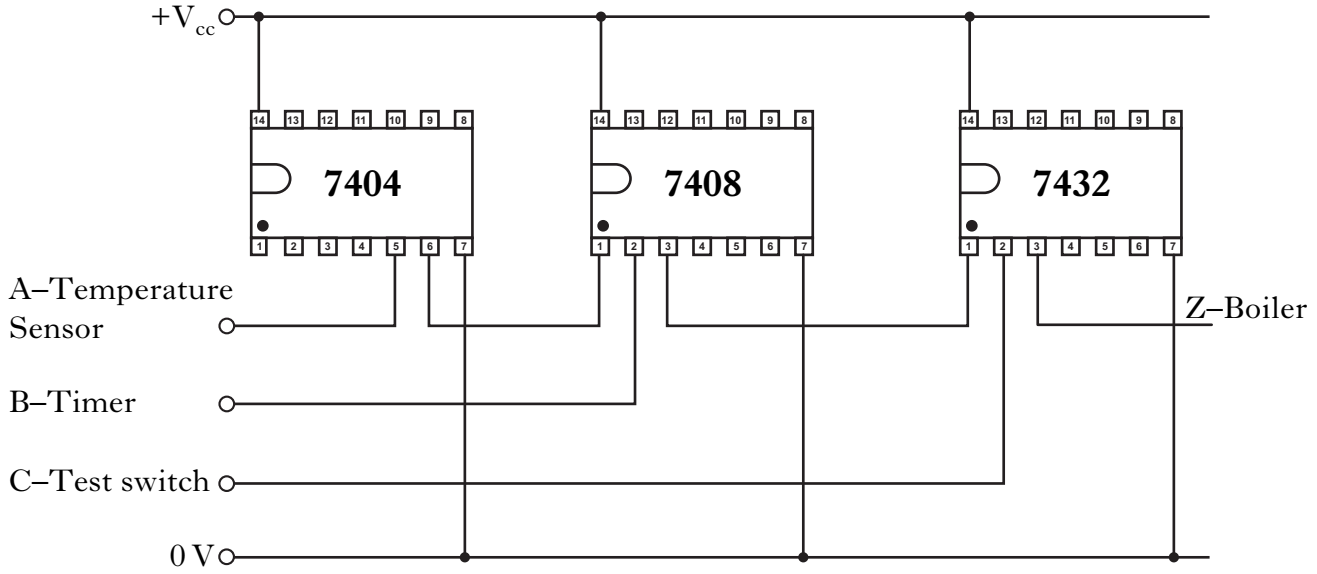
6. A music venue has a system to cut off the power supply if a band plays too loudly. The system is operated by a microcontroller.

A flowchart for the control system is shown below.

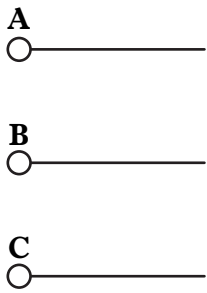




7. Part of an electronic circuit used to control a central heating system is shown below.



(a) Complete, with reference to the Data Booklet and the wiring diagram, the logic diagram for the central heating system.



6  
5  
4  
3  
2  
1  
0

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2	
1	
0	
2	
1	
0	
1	
0	
1	
0	

**7. (continued)**

(b) TTL Integrated Circuits (ICs) are used in the prototype but CMOS ICs are chosen for the final product.

State two **advantages** of CMOS ICs over the TTL ICs.

1 \_\_\_\_\_

2 \_\_\_\_\_

(c) An engineer designed and tested the circuit using a computer simulation.

State two reasons why new circuits are often tested on a computer first.

1 \_\_\_\_\_

2 \_\_\_\_\_

(d) The engineer assembled the circuit on a breadboard and used an LED to show a high output.

(i) State the full name of an LED.

\_\_\_\_\_

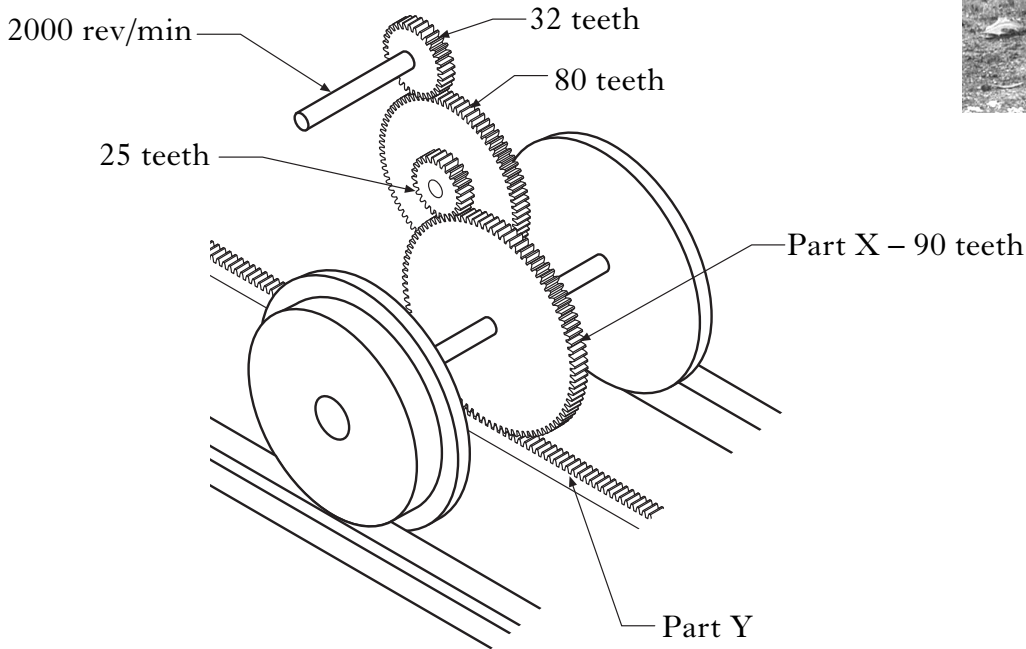
(ii) Draw the symbol for an LED below.

**[Turn over**



**[Turn over for Question 9 on *Page sixteen***

9. A model train climbs a steep slope at an amusement park. A simplified diagram of the train drive system is shown here.



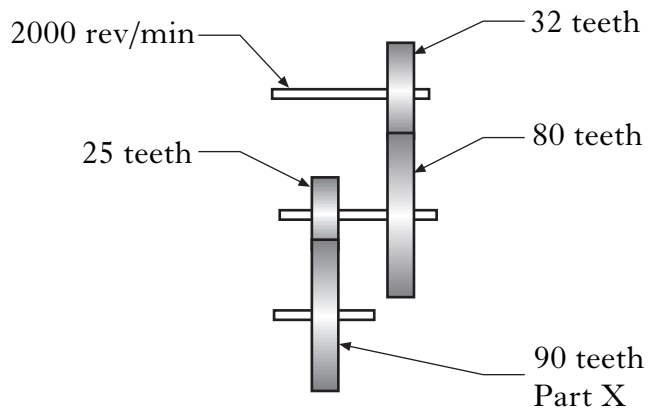
(a) State the names of the labelled parts of the drive system in the diagram above.

Part X \_\_\_\_\_

Part Y \_\_\_\_\_

2  
1  
0

(b) A simplified diagram of the train drive system is shown. Calculate the speed of the 90 tooth gear.



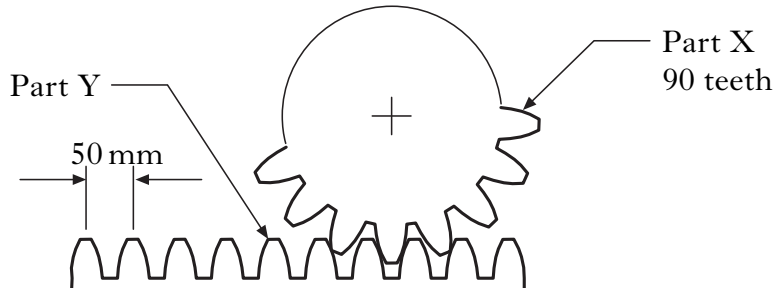
\_\_\_\_\_ rev/min

4  
3  
2  
1  
0

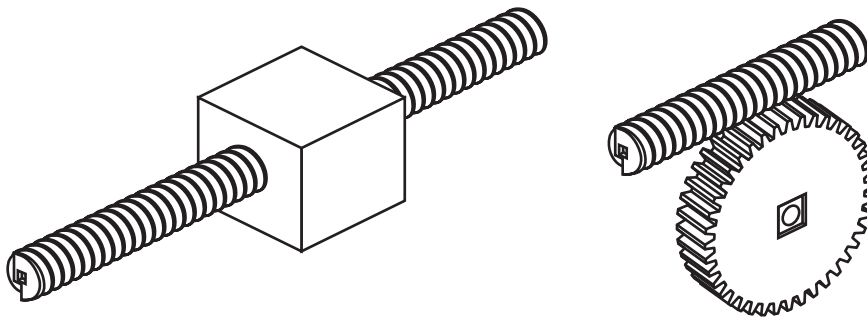


9. (continued)

- (c) Calculate the linear speed of the train along the track. The pitch of Part Y is 50 mm.



- (d) State the names of the mechanisms shown below.



- (i) Worm and \_\_\_\_\_  
 (ii) Worm and \_\_\_\_\_  
 (iii) State an advantage in the use of a worm in a lifting system.

\_\_\_\_\_  
 \_\_\_\_\_

[Turn over

2  
1  
0

2  
1  
0

1  
0

10. A microcontroller operates the motors in a robotic dog. To make the dog move in a life-like way the motors must be able to turn at a slower speed.



(a) Describe, with the aid of a sketch, or sketches, how a microcontroller program can be used to make a motor turn at a slower speed.

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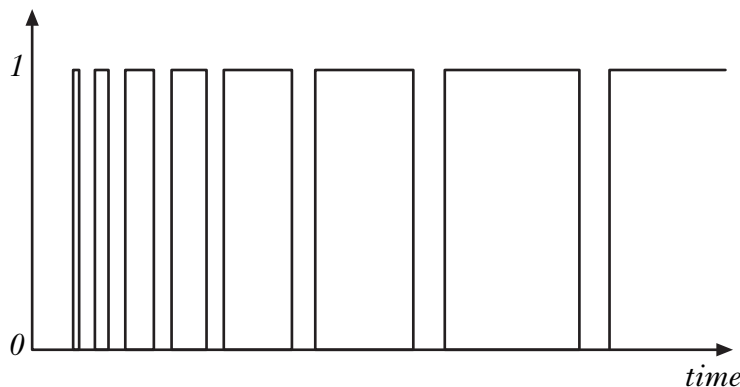


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3  
2  
1  
0

To reduce damage to the robotic toy the program uses a “soft start” technique when operating the motors. The “soft start” is illustrated in the diagram below.

The diagram below shows the output signal to the motor.



(b) Describe, with reference to the diagram, what will happen to a motor when the “soft start” is used.

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1  
0

[END OF QUESTION PAPER]

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