FOR OFFICIAL USE

X036/201

X036110 11

Total Mark

NATIONAL QUALIFICATIONS 2011

FRIDAY, 27 MAY 9.00 AM – 11.30 AM

TECHNOLOGICAL STUDIES
INTERMEDIATE 2

Do not open this paper until you are told to do so.

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

Scottish candidate number

Number of seat

1 Answer all the questions in Section A and any **two** questions in Section B.

2 Read each question carefully before you answer.

3 Write your answers in the spaces provided.

4 **Show all working and units.**

5 Do **not** write in the margins.

6 **Do not sketch in ink.**

7 Reference should be made to the Standard Grade and Intermediate 2 Data Booklet (2008 edition) which is provided.

8 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.

Use blue or black ink. Pencil may be used for graphs and diagrams only.

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SECTION A

Marks

Attempt ALL questions (Total 60 marks)

1. A simplified block diagram for a microcontroller is shown in Figure Q1.

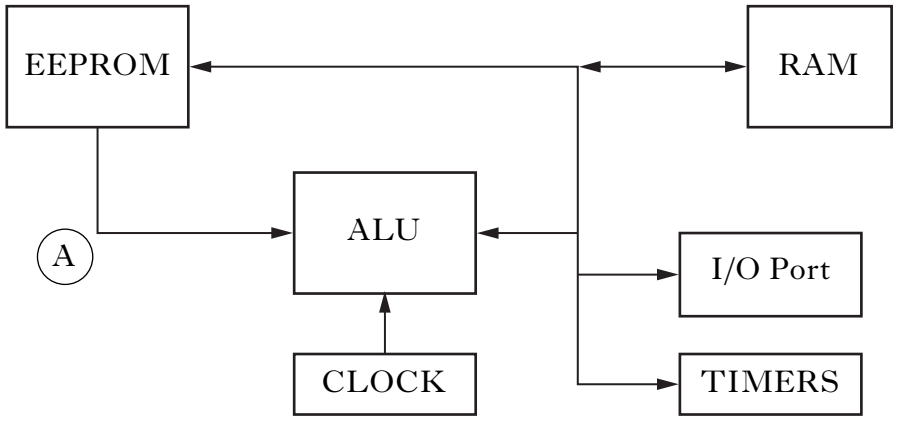

Figure Q1

(*a*) (i) State the **function** of the following microcontroller sub-systems.

ALU _____

_____

CLOCK _____

_____

EEPROM _____

_____ **3**

(ii) State the name of part (A) which carries information between the sub-systems.

_____ **1**

The PBASIC command shown below was used to set up the input and output pins on the microcontroller.

let dirs = 41

(*b*) (i) Complete the PBASIC command below by converting 41 to binary.

let dirs = % _____ **1**

(ii) State which pins are set as **outputs** with this PBASIC command.

_____ **1**

(6)

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2. The logic diagram for a security system is shown in Figure Q2(*a*). *Marks*

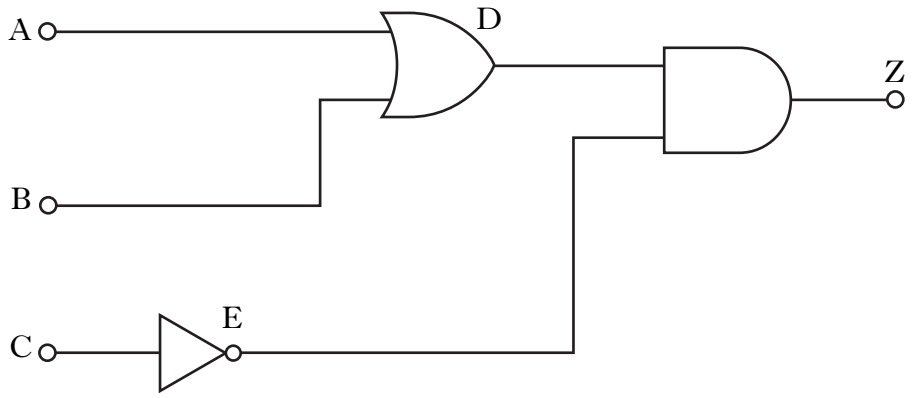

Figure Q2(*a*)

(*a*) With reference to the logic diagram shown in Figure Q2(*a*):

(i) write the Boolean expression for output Z in terms of inputs A, B and C;

Z = _____ **3**

(ii) complete the truth table below for the security system.

A	B	C	D	E	Z
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

3

An LED is used in the security system to show when it is in operation.

(*b*) (i) Complete the circuit shown in Figure Q2(*b*) so that it will allow an LED to indicate when the security system is in operation.

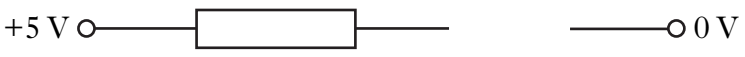

Figure Q2(*b*) **2**

(ii) State the **function** of the resistor in the circuit.

_____ **1**

(9)

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Marks

3. A ski jumper and take-off ramp is shown in Figure Q3.

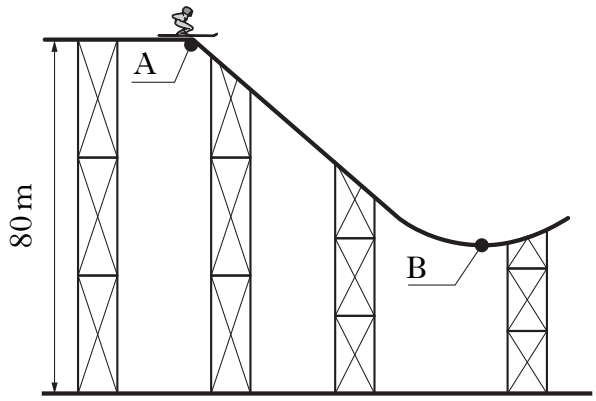

Figure Q3

The ski jumper has a mass of 65 kg.

(*a*) Calculate, showing all working and units, the potential energy of the ski jumper when stationary at point A.

2

The ski jumper descends down the ramp and has a potential energy of 31·5 kJ at point B.

(*b*) Calculate:

(i) the kinetic energy of the ski jumper at point B (assume no loss of energy);

2

(ii) the velocity of the ski jumper at point B.

3

(7)

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Marks

4. A control system used to maintain the speed of a DVD while playing is shown in Figure Q4.

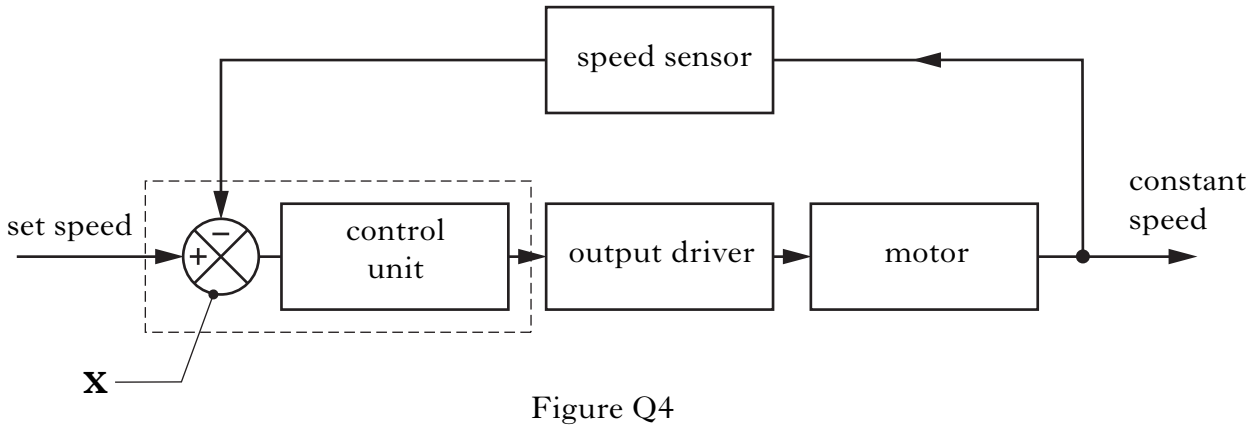


Figure Q4

(*a*) State the name of symbol **X**.

_____ **1**

(*b*) (i) State the type of feedback shown in Figure Q4.

_____ **1**

(ii) Explain why this type of feedback is used.

_____

_____ **1**

(*c*) Describe, using appropriate terminology, the operation of the system.

The speed is set _____

_____

_____

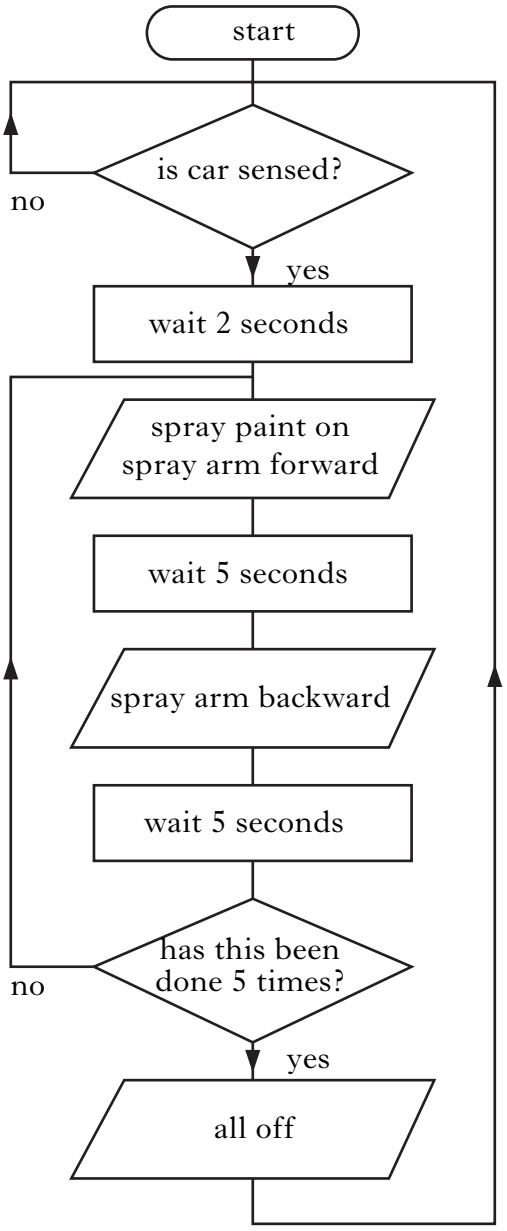
_____

_____ **3**

(6)

[Turn over

5. A car production line uses a microcontroller to operate a spray painting system. The flowchart and the input and output connections are shown in Figure Q5.



input connection	pin	output connection
	7	spray paint
	6	spray arm forward
	5	spray arm backward
	4	
	3	
car sensor	2	
	1	
	0	

Figure Q5

Marks

5. (continued)

(*a*) Complete, with reference to the flowchart, input/output connections and the Data Booklet, the missing PBASIC commands.

```
init:   symbol counter = b0          'set b0 as counter
        let dirs = %11100000         'set input and output connections
main:   _____________________        'test car sensor
        _____________________        'wait 2 seconds
        _____________________        'set counter for 1 to 5
        let pins = %11000000         'spray paint on and spray arm forward
        pause 5000                   'wait 5 seconds
        _____________________        'spray arm backward
        pause 5000                   'wait 5 seconds
        _____________________        'check counter
        _____________________        'all off
        _____________________        'loop to main
```

7

(*b*) State an advantage of using a microcontroller over a hardwired electronic circuit.

_____

_____ **1**

(8)

[Turn over

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Marks

6. An electrical circuit used to operate three lamps in a child's night light is shown in Figure Q6.

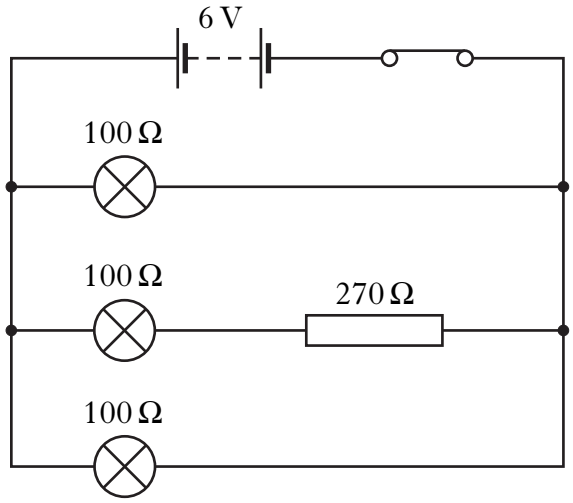

Figure Q6

Calculate, showing all working and units:

(*a*) (i) the combined resistance of the lamp and resistor branch;

1

(ii) the **total** circuit resistance;

3

(iii) the **total** circuit current;

2

(iv) the power used by the circuit.

2

(*b*) Indicate, with a cross (✗) on Figure Q6, where an ammeter should be connected to measure the **total** current in the circuit.

1

(9)

[Turn over for Question 7 on *Page ten*

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Marks

7. The drive system used in an airport luggage conveyor is shown in Figure Q7(*a*).

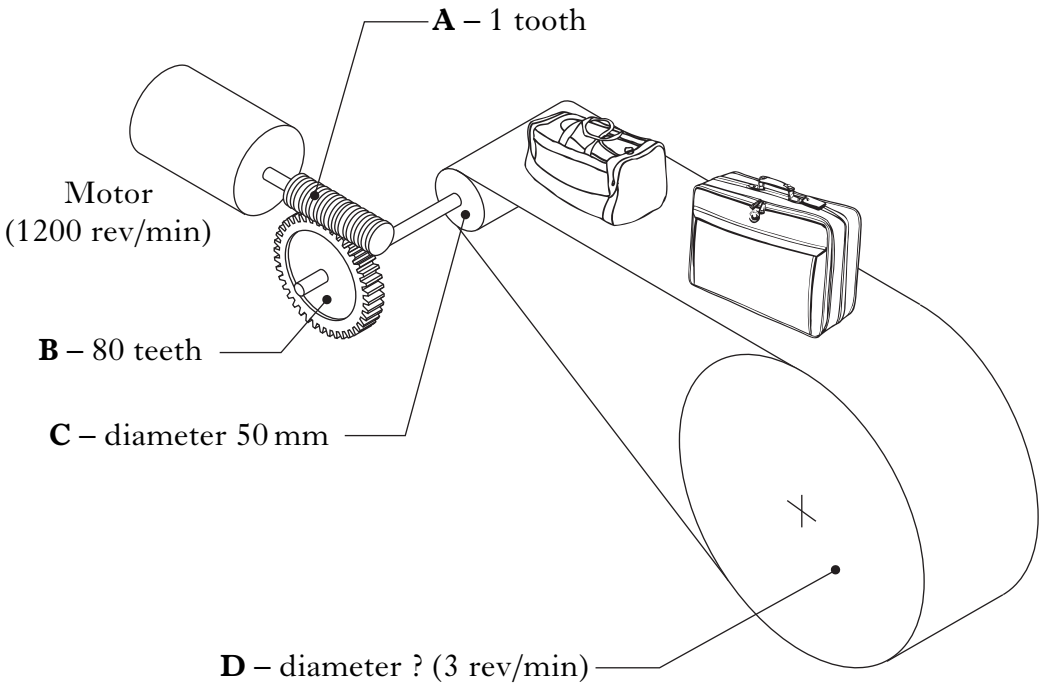


Figure Q7(*a*)

(*a*) State the name of gear **A**.

_____ **1**

(*b*) Calculate, showing all working and units:

(i) the velocity ratio of the drive system;

2

(ii) the diameter of pulley **D**.

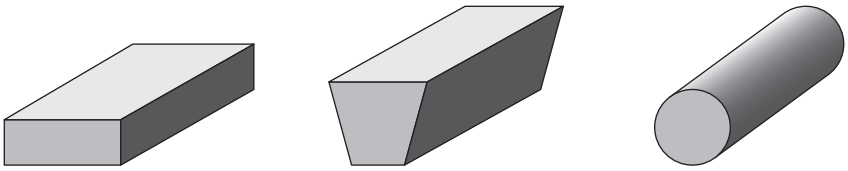
3

Marks

7. (continued)

The gearing is to be replaced with a belt drive.

The three belts shown in Figure Q7(*b*) were considered.



Belt 1 Belt 2 Belt 3

Figure Q7(*b*)

(*c*) (i) State, with reference to Figure Q7(*b*), which belt would be used to reduce the amount of slippage in the drive system.

_____ **1**

(ii) Explain why the belt you have chosen reduces slippage.

_____

_____ **1**

(8)

[Turn over

8. The pneumatic circuit shown in Figure Q8 is used to test the life span of a chair.

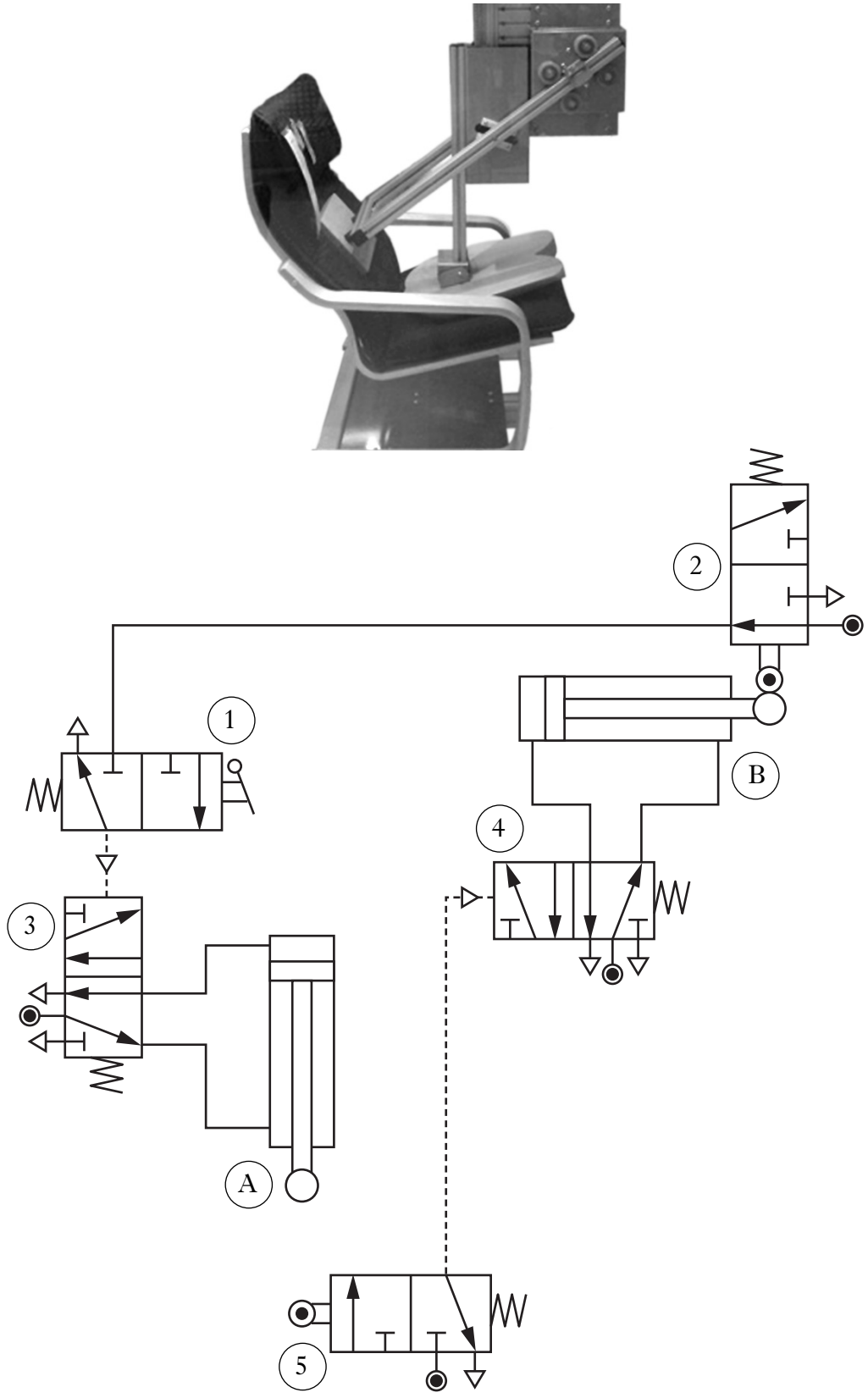


Figure Q8

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Marks

8. (continued)

(*a*) State the **full** name of the following pneumatic components.

Valve (1) _____

Valve (3) _____ **2**

(*b*) Describe, with reference to Figure Q8, the operation of the pneumatic circuit.

Valve (1) is actuated _____

_____

_____

_____

_____

_____

_____

_____

_____ **5**

(7)

[*END OF SECTION A*]

[Turn over

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SECTION B

Marks

Attempt any TWO questions (Total 40 marks)

9. Figure Q9 shows the circuit diagram for an automatic water heater.

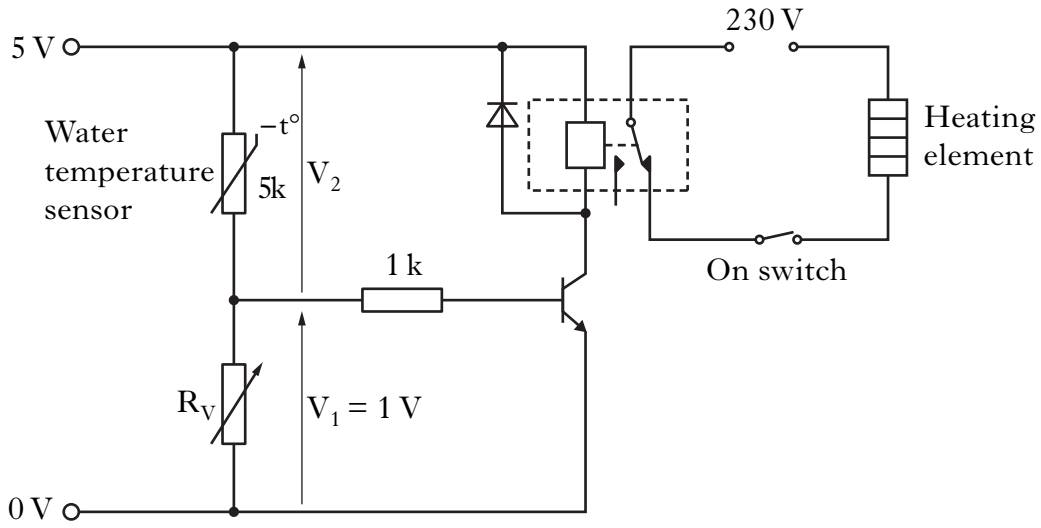

Figure Q9

(*a*) Describe, using appropriate terminology, the operation of the circuit when the on switch is pressed to heat the water.

When the on switch is pressed _____

_____

_____

_____

_____

_____

_____ **4**

(*b*) A SPDT relay is used in the system.

(i) State the full name of this relay.

_____ **1**

(ii) Explain why a relay is required to operate the heating element.

_____

_____ **1**

Marks

9. (continued)

The system is set to heat water to 25 °C.

(*c*) Determine, with reference to the Data Booklet, the thermistor type used in the system if it has a resistance of 5 kΩ at 25 °C.

_____ **1**

(*d*) State the **function** of the variable resistor in the circuit.

_____

_____ **1**

When the transistor is saturated, V_1 is found to be 1 V.

(*e*) Calculate:

(i) the voltage V_2;

1

(ii) the resistance of the variable resistor R_V.

2

The 230V, 6 A heating element takes 20 minutes to heat 25 kg of water to 25 °C.

(*f*) Calculate:

(i) the electrical energy supplied to the heating element;

3

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Marks

9. (*f*) (continued)

(ii) the heat energy transferred to the water if the system is 85% efficient;

1

(iii) the change in temperature of the 25 kg of water during this time;

2

(iv) the starting temperature of the water, if the final temperature is 25 °C.

1

(*g*) Describe **two** reasons why it is important to conserve energy.

_____

_____

_____ **2**

(20)

10. Figure Q10(*a*) shows a window cleaner's platform. *Marks*

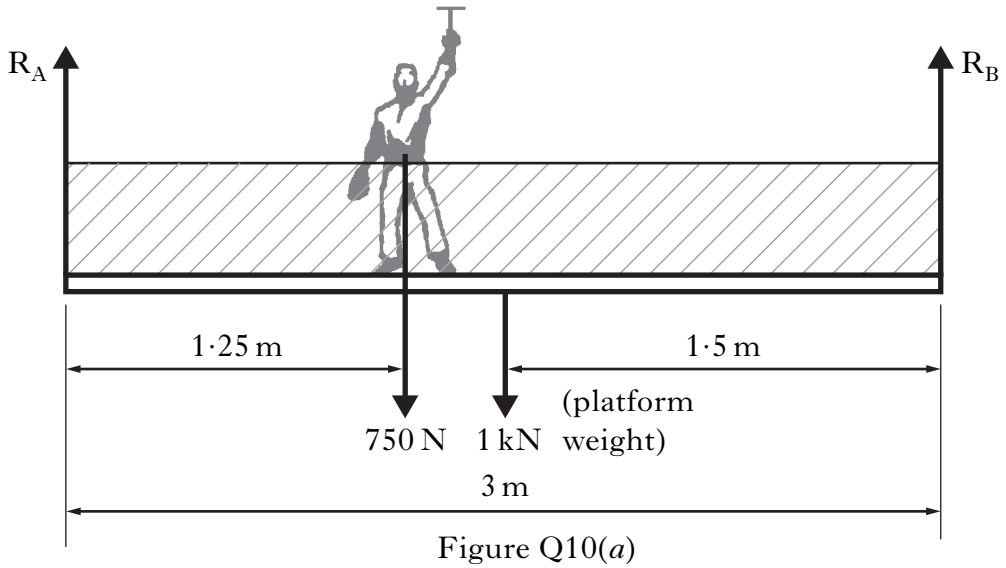


Figure Q10(*a*)

(*a*) Draw a free body diagram of the system shown in Figure Q10(*a*). **2**

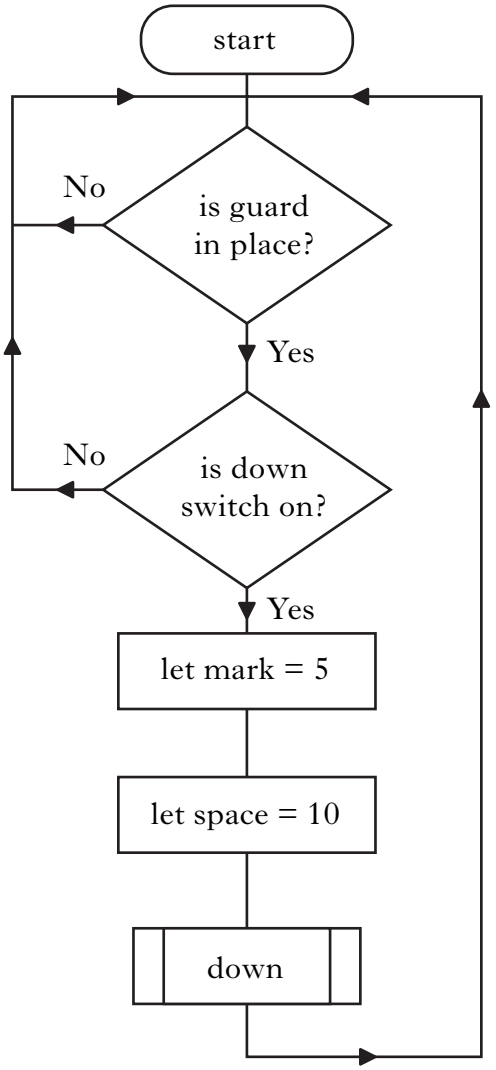
(*b*) Calculate:

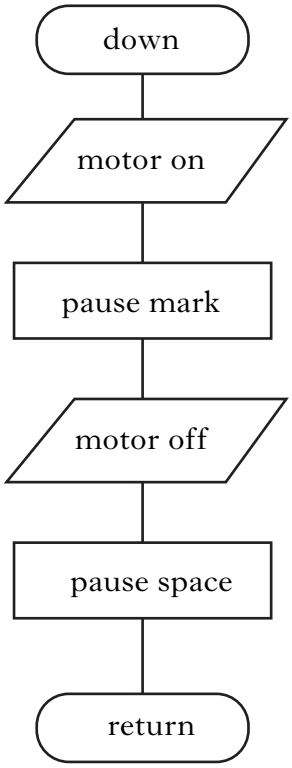
(i) the reaction force R_A (take moments about R_B); **3**

(ii) the reaction force R_B. **2**

10. (continued)

The platform is moved by a motor operated by a microcontroller. The flowchart for lowering the platform and the input and output connections are shown in Figure Q10(*b*).





input connection	pin	output connection
	7	motor
	6	
	5	
	4	
	3	
	2	
guard sensor	1	
down switch	0	

Figure Q10(*b*)

Marks

10. (continued)

(*c*) Complete, with reference to the flowchart, Data Booklet and the input/output connections, the PBASIC commands to lower the platform.

```
init:   let dirs = %11110000        'set input and output connections
        symbol mark = b0            'set b0 as mark
        _____                       'set b1 as space
main:   _____                       'test guard sensor
        _____                       'test down switch
set:    let mark = 5                'set mark to 5 ms
        let space = 10              'set space to 10 ms
        _____                       'jump to sub-procedure down
        goto main                   'loop to main
        _____                       'end of main program
down:   _____                       'motor on
        _____                       'wait mark
        low 7                       'motor off
        pause space                 'wait space
        _____                       'return to main program
```

8

[Turn over

Marks

10. (continued)

Pulse Width Modulation (PWM) is used to control the speed of the motor.

(*d*) (i) Complete Figure Q10(*c*), with reference to the flowchart, to show how PWM is used to control the speed of this motor. **2**

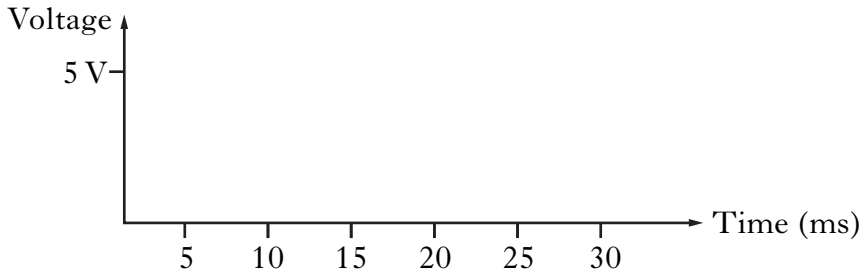


Figure Q10(*c*)

(ii) Label the **mark** and **space** on Figure Q10(*c*). **1**

The values for the mark and space are stored in the RAM of the microcontroller.

(*e*) State:

(i) the full name of RAM;

_____ **1**

(ii) the meaning of the term **volatile**.

_____ **1**

(20)

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11. Figure Q11(*a*) shows an incomplete pneumatic circuit used to fix tops on shampoo bottles.

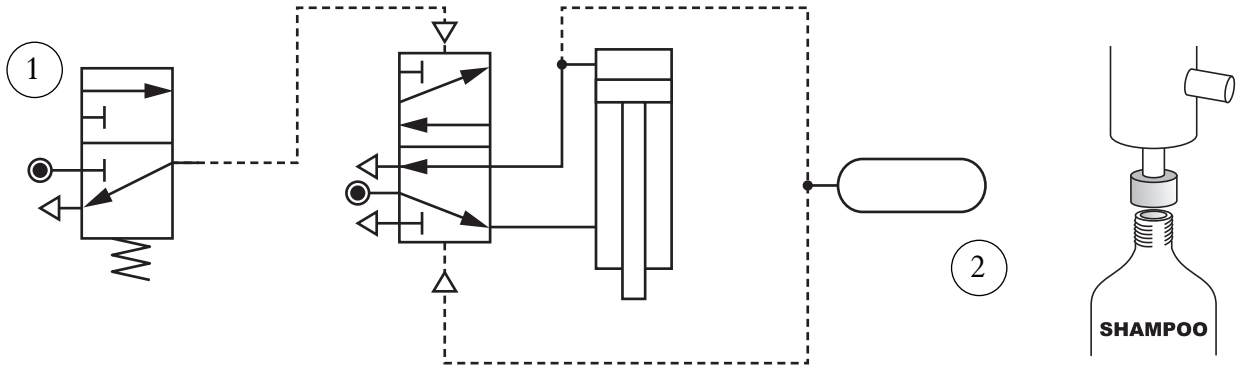


Figure Q11(*a*)

Valve (1) is to be actuated by an **electrical** signal.

(*a*) (i) State the name of this actuator.

_____ **1**

(ii) Sketch the symbol for this actuator **below**.

1

(*b*) (i) Sketch **on Figure Q11(*a*)** the pneumatic device that will create an **adjustable** time delay after the piston outstrokes. **3**

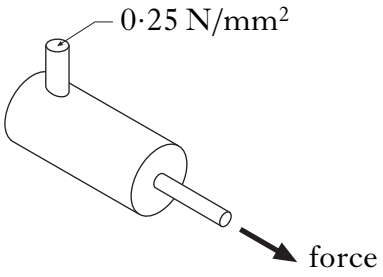
(ii) State the name of component (2).

_____ **1**

Marks

11. (continued)

A 10 mm diameter cylinder has air supplied at a pressure of 0·25 N/mm^2.



(*c*) Calculate the force of the piston as it outstrokes.

3

(*d*) Explain why the instroke force of the piston will be **less** than the outstroke force.

_____

_____

_____ **2**

(*e*) State a reason, other than cost, for using pneumatic systems in an industrial environment.

_____

_____ **1**

11. (continued) *Marks*

The logic diagram to control valve (1) is shown in Figure Q11(*b*).

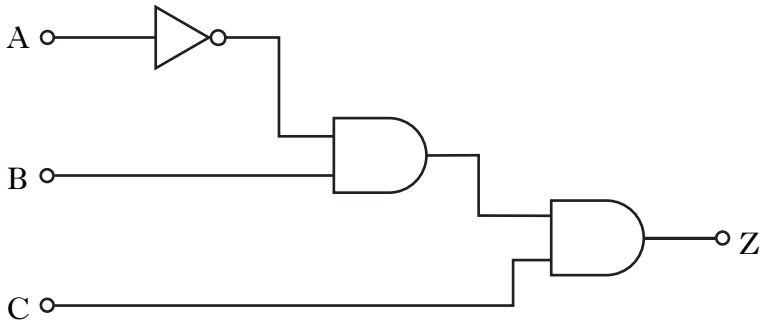


Figure Q11(*b*)

A 7404 and a 7408 Integrated Circuit (IC) are required to construct the control system.

(*f*) State, with reference to the Data Booklet:

(i) the **full** name of each IC;

7404 _____

7408 _____ **2**

(ii) the name of this IC's logic family;

_____ **1**

(iii) a suitable supply voltage for the ICs.

_____ **1**

[Turn over

11. (continued) *Marks*

(*g*) Complete the wiring diagram on Figure Q11(*c*) for the control system in Figure Q11(*b*).

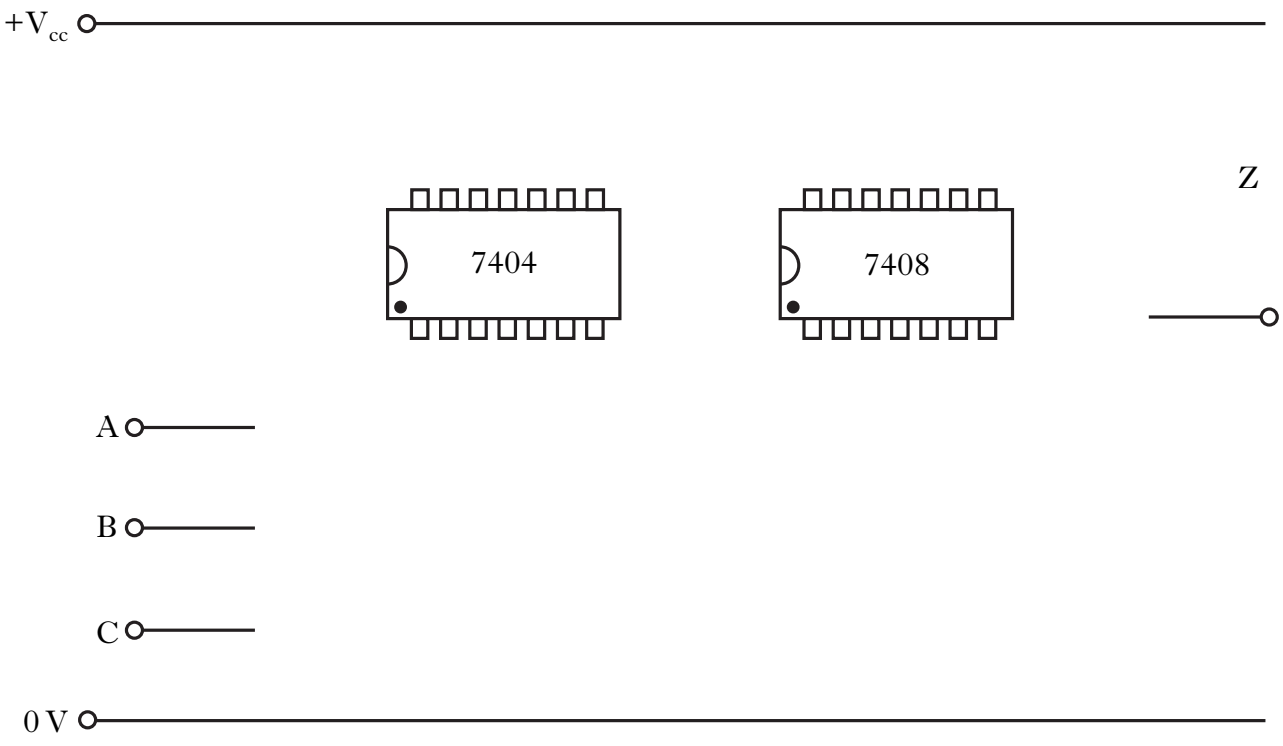


Figure Q11(*c*) **4**

(20)

[*END OF QUESTION PAPER*]