FOR OFFICIAL USE

X036/201

X0361101 1

Total Mark

NATIONAL QUALIFICATIONS 2010

MONDAY, 7 JUNE 1.00 PM – 3.30 PM

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

Attempt ALL questions (Total 60 marks)

1. The truth table for a digital electronic circuit is given below.

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	1

With reference to the truth table:

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

Z =

2

(ii) draw a logic diagram for the circuit.

3

CMOS ICs were used to construct the logic circuit.

(*b*) (i) State a possible disadvantage in using CMOS ICs.

_____

1

(ii) State the full name of the abbreviation IC.

_____

1

(7)

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2. The symbol for a pneumatic valve is shown in Figure Q2(*a*).

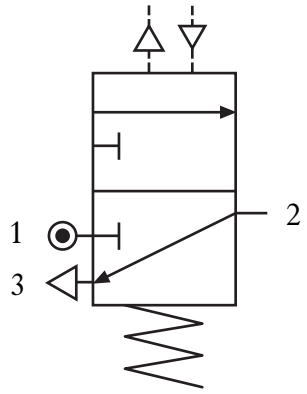

Figure Q2(*a*)

(*a*) (i) State the **full** name of the pneumatic valve.

_____ **1**

(ii) Complete the table below for the valve ports.

Port	**Connection**
1	
2	Output port
3	

2

Marks

2. (continued)

Figure Q2(*b*) shows the dimensions of a double acting cylinder.

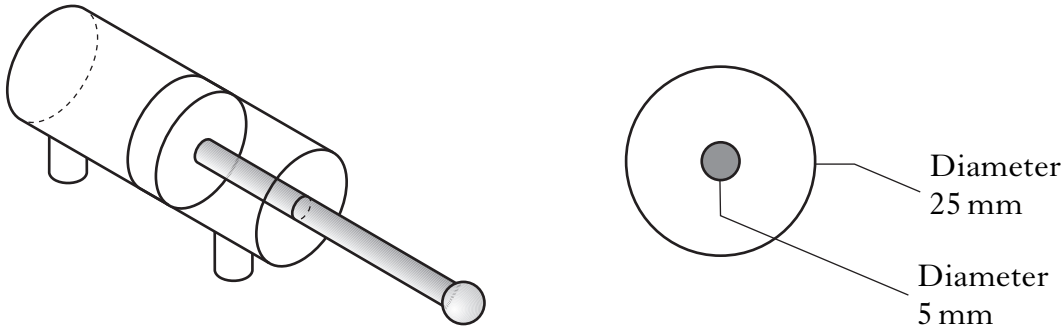

Figure Q2(*b*)

(*b*) Calculate:

(i) the effective area of the piston as it instrokes;

3

(ii) the **instroking force** of the piston if air is supplied at a pressure of 0·6 N/mm^2.

2

(8)

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3. Figure Q3 shows a person with a mass of 75 kg standing on a platform 10 m above a pool.

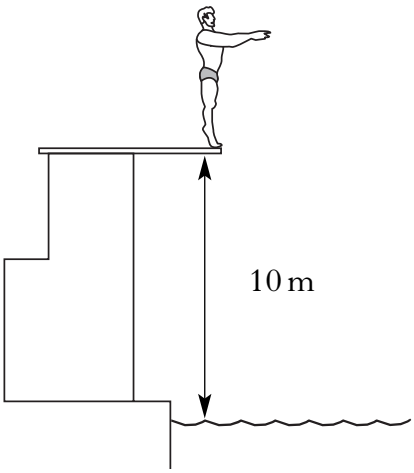

Figure Q3

(*a*) Calculate, showing all working and units, the potential energy of the person.

2

The person **jumps up** off the platform.

(*b*) (i) Calculate the height reached above the pool if the person's maximum potential energy is 7·7 kJ.

2

(ii) Explain where the "extra" energy that increases the height of the person above the pool comes from and state the form of this energy.

_____

_____

_____ **2**

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3. (continued)

(*c*) State, by applying the law of conservation of energy and assuming no energy losses, the **kinetic energy** of the person:

(i) at the highest point of the jump;

1

(ii) at the point of entering the water.

1

(8)

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4. Figure Q4 shows a simplified sub-system diagram for a hand dryer.

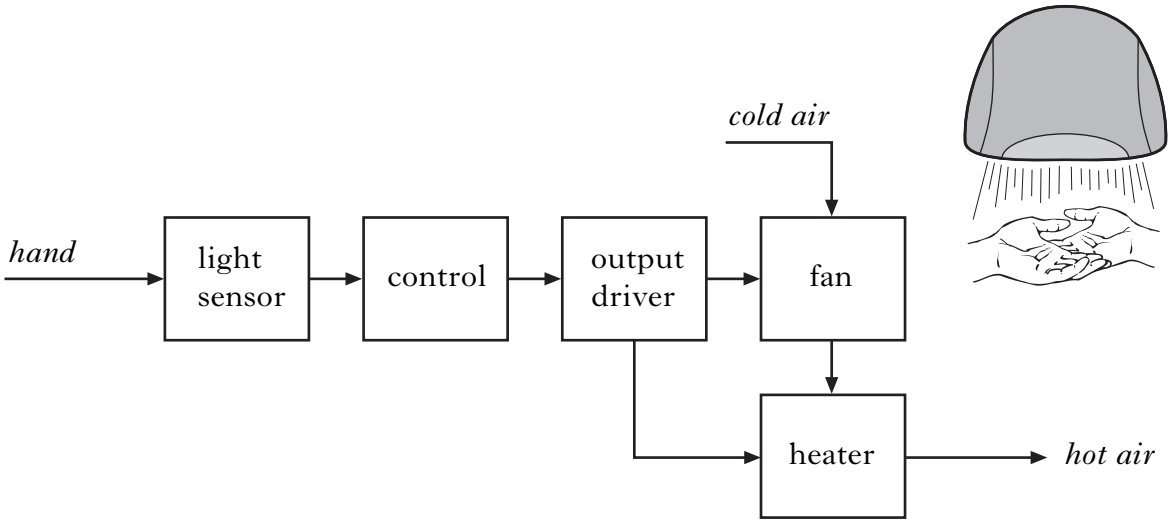

Figure Q4

(*a*) Describe, with reference to Figure Q4, the operation of the hand dryer.

When a hand is placed in front of the light sensor

3

(*b*) Add the system boundary to Figure Q4. **1**

(*c*) (i) State the type of control shown in Figure Q4.

1

(ii) Explain the reason for your answer in (*c*)(i).

1

(*d*) State the name of the electronic **components** that would be required for the light sensor sub-system.

1

2 **2**

(*e*) State the name of the electronic **component** that would be suitable for the output driver.

1

(9)

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5. An electrical circuit is shown in Figure Q5.

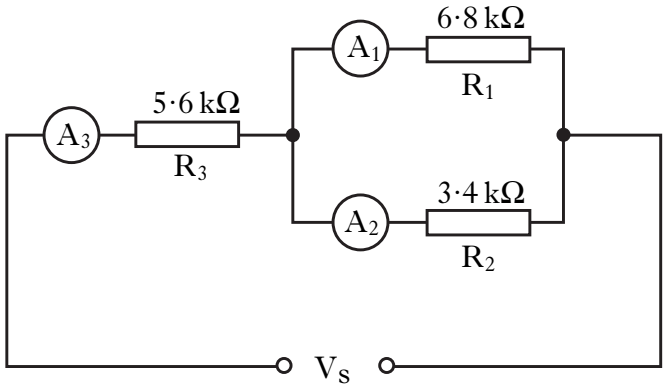


Figure Q5

(*a*) Calculate:

(i) the equivalent resistance of the parallel resistors R_1 and R_2;

2

(ii) the total circuit resistance.

1

The current measured in ammeter A_1 is 0·75 mA.

(*b*) Calculate:

(i) the readings in ammeters A_2 and A_3;

A_2: _____

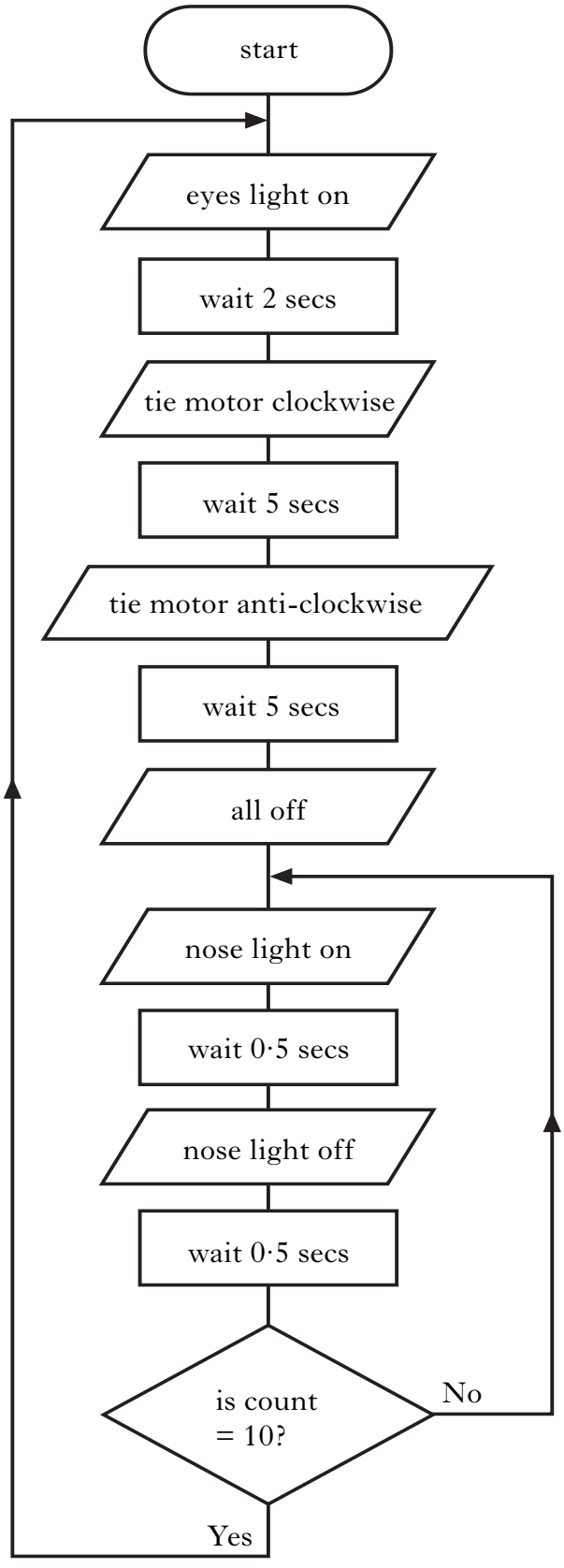
A_3: _____ **2**

(ii) the supply voltage V_S.

2

(7)

6. A microcontroller is used in a model clown. The flowchart for the control of the model and the input and output connections are shown in Figure Q6.



input connection	pin	output connection
	7	eyes light
	6	tie motor clockwise
	5	tie motor anti-clockwise
	4	nose
	3	
	2	
	1	
	0	

Figure Q6

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6. (continued)

Complete, with reference to the flowchart and the Data Booklet, the PBASIC program for the clown.

```
init:   symbol counter = b0          'set b0 as counter
        _____________________        'set pin 7,6,5,4 as output
main:   high 7                       'eyes light on
        pause 2000                   'wait 2 seconds
        _____________________        'tie motor clockwise
        pause 5000                   'wait 5 seconds
        _____________________        'tie motor anti-clockwise
        pause 5000                   'wait 5 seconds
        _____________________        'all off
        _____________________        'set counter for 1 to 10
        high 4                       'nose light on
        pause 500                    'wait 0·5 seconds
        low 4                        'nose light off
        pause 500                    'wait 0·5 seconds
        _____________________        'check if counter = 10
        _____________________        'loop to main
```

(7)

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7. An electronic circuit to turn on a buzzer when the temperature in a room becomes too hot is shown in Figure Q7.

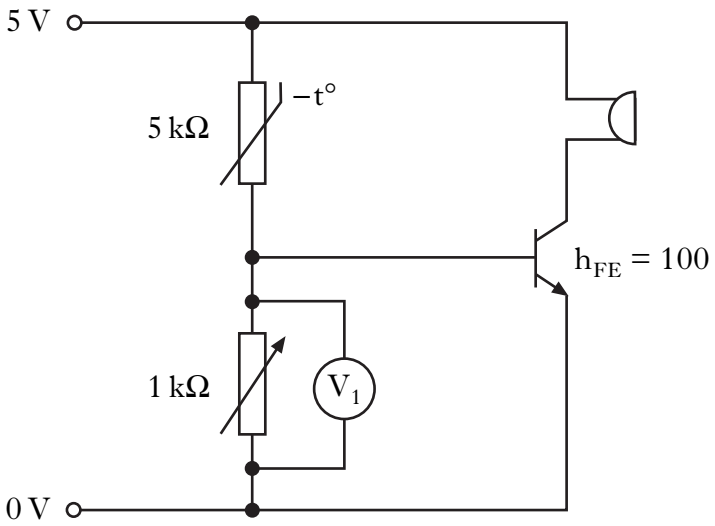

Figure Q7

(*a*) State, with reference to the Data Booklet, the temperature that will produce a resistance of 5 kΩ in a type 2 thermistor.

_____ **1**

For the conditions shown in Figure Q7:

(*b*) (i) calculate the voltage V_1;

2

(ii) state if the buzzer is on or off and explain your answer.

_____

_____ **2**

(*c*) Calculate the current flowing through the buzzer if the base current is 50 μA and the current gain (h_{FE}) is 100.

2

(*d*) State the name of the leg identified by the arrowhead on the transistor symbol in Figure Q7.

_____ **1**

(8)

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8. A gear system for operating a theatre curtain is shown in Figure Q8.

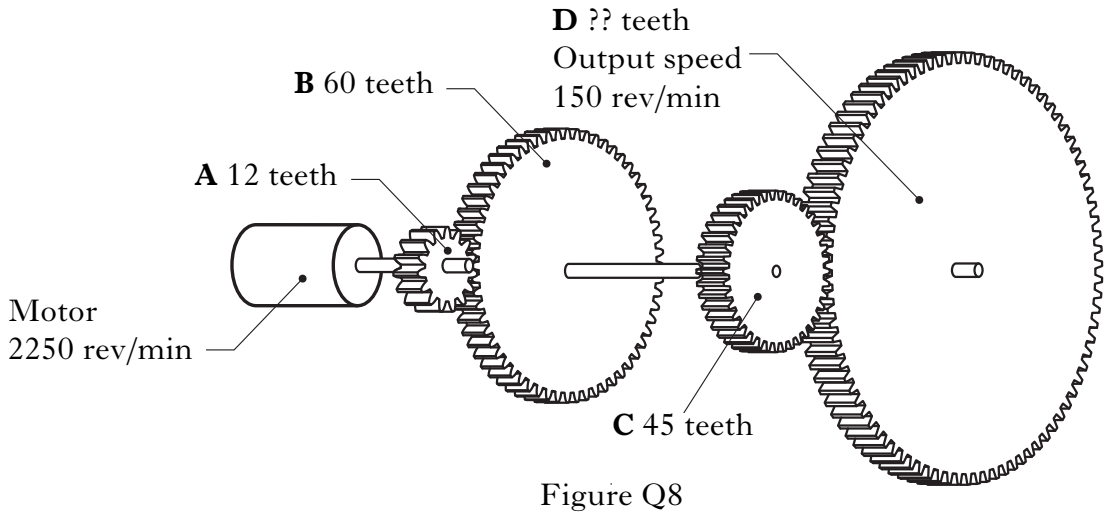


Figure Q8

(*a*) State the name of the type of gear system shown in Figure Q8.

_____ **1**

(*b*) Calculate:

(i) the velocity ratio of the system when gear D rotates at 150 rev/min.

1

(ii) the ratio of gear B to gear A;

1

(iii) the number of teeth on gear D to produce the correct output speed.

2

(*c*) State **one** advantage of a gear system made from plastic rather than steel gears.

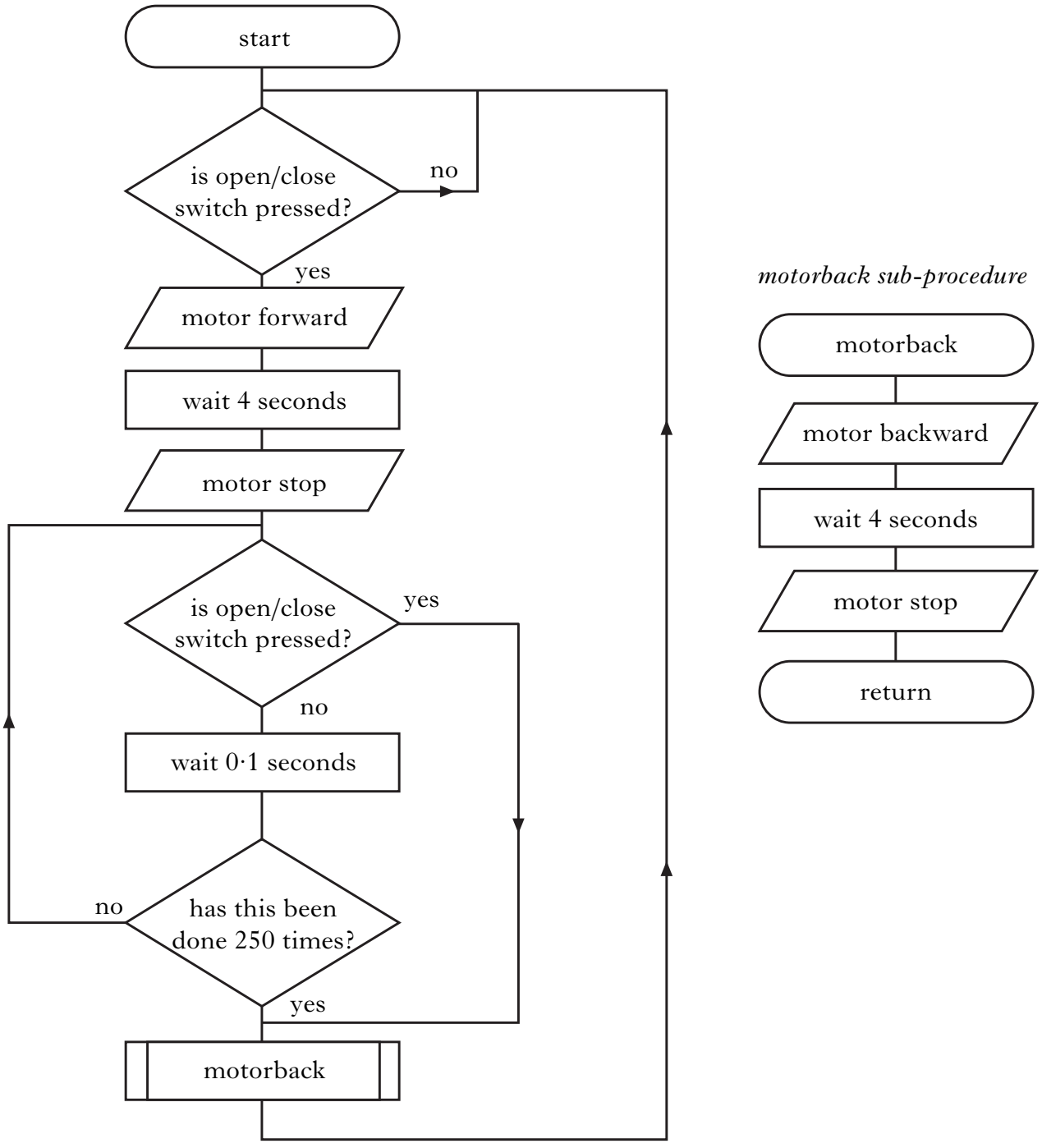
_____ **1**

(6)

SECTION B

Attempt any TWO questions (Total 40 marks)

9. A microcontroller is used to operate a DVD disc tray. The flowchart and the input and output connections are shown in Figure Q9(*a*).



input connection	pin	output connection
	7	
	6	
	5	motor backward
	4	motor forward
	3	
open/close switch	2	
	1	
	0	

Figure Q9(*a*)

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9. (continued)

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

```
init:       symbol counter = b0              'set b0 as counter
            let dirs = %00110000             'set pin 4 and 5 as outputs
main:       _____                            'test open/close switch
            high 4                           'motor forward
            pause 4000                       'wait 4 seconds
            _____                            'motor stop
            for counter = 1 to 250           'set counter for 1 to 250
                _____                        'test open/close switch
                _____                        'wait 0·1 seconds
            _____                            'check if counter is 250
label1:     _____                            'go to sub-procedure motorback
            _____                            'loop to main
            end                              'end of program

motorback:  high 5                           'motor backward
            pause 4000                       'wait 4 seconds
            low 5                            'motor stop
            _____                            'return to program
```

8

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9. (continued)

(*b*) Calculate, with reference to Figure Q9(*a*), the time taken before the tray automatically closes.

1

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

(*c*) (i) Complete the graph, Figure Q9(*b*), to show a PWM signal and label the **mark** and **space** time.

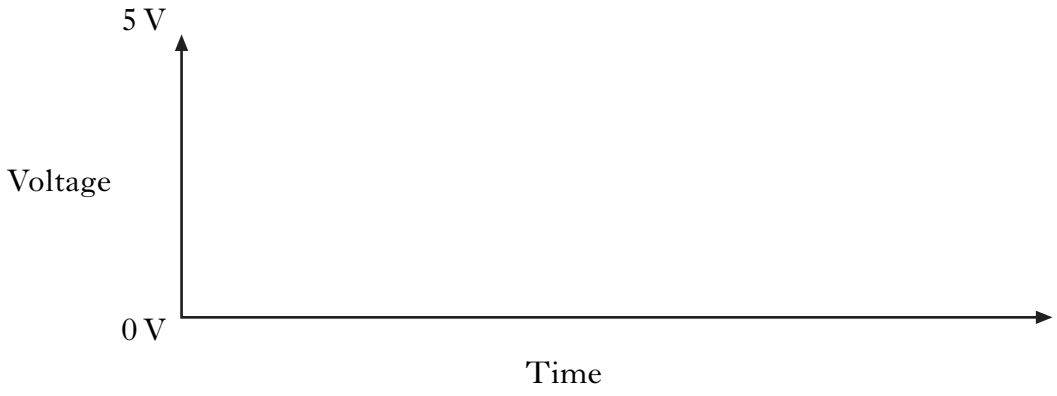

Figure Q9(*b*)

3

(ii) State **one** advantage of using PWM to reduce a motor's speed.

_____

1

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9. (continued)

A unit used to support the DVD player, an entertainment system and television is shown in Figure Q9(*c*).

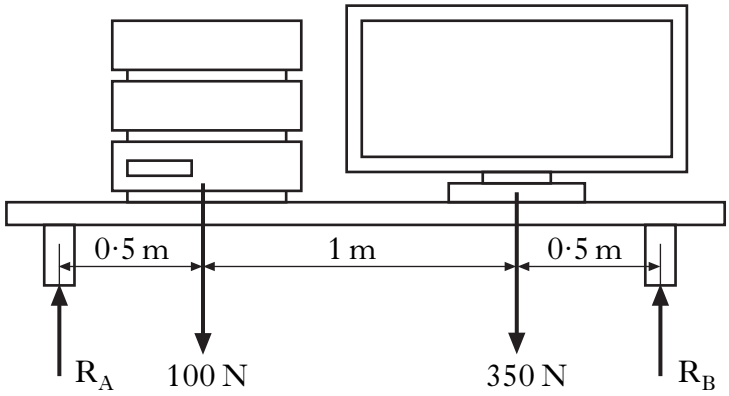

Figure Q9(*c*)

(*d*) Draw a free body diagram for the unit shown.

2

(*e*) Calculate:

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

3

(ii) the reaction force R_B.

2

(20)

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10. A circuit used in a factory production line is shown in Figure Q10.

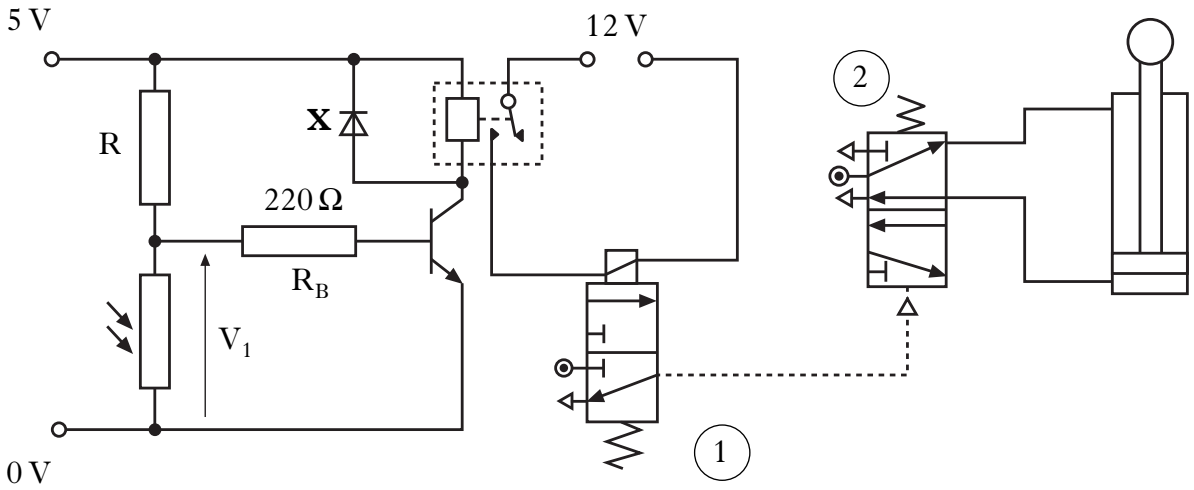

Figure Q10

The relay used in the circuit operates at 5 V, 0·2 A.

(*a*) Calculate:

(i) the transistor base current (I_B), when the gain of the transistor (h_{FE}) is 150;

2

(ii) the voltage dropped across resistor R_B;

2

(iii) the voltage (V_1) dropped across the LDR when the transistor is saturated.

2

Marks

10. (continued)

(*b*) State, with reference to the Data Booklet, the resistance of an LDR at 200 lux.

_____ **1**

(*c*) Describe how the circuit could be altered to allow for different "switch on" levels.

_____

_____ **1**

(*d*) (i) State the name of component **X**.

_____ **1**

(ii) State the function of component **X** in the circuit.

_____

_____ **1**

A SPDT relay is used in the circuit.

(*e*) (i) State what SPDT stands for.

_____ **1**

(ii) Explain why a relay is required to activate the pneumatic circuit.

_____

_____ **1**

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

Valve (1) _____

Valve (2) _____ **2**

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10. (continued)

(*g*) Draw the symbols for the **two** pneumatic components required to create a **controlled time delay**.

2

(*h*) Calculate the piston **diameter** used to produce an outstroke force of 150 N when air is supplied at a pressure of 0·5 N/mm^2.

3

(*i*) Describe the effect on the size of the outstroke force, if a **larger** diameter cylinder is used with the same air pressure.

1

(20)

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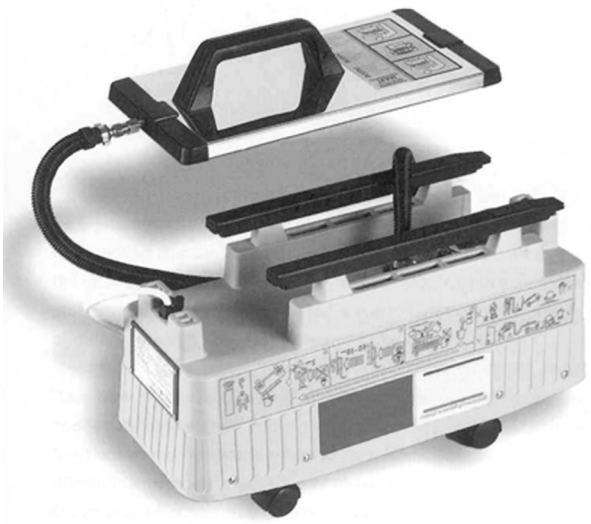
11. A wallpaper stripper heats water to produce steam allowing the user to easily remove wallpaper.



The 230 V, 5 A wallpaper stripper heats 5 kg of water in 20 minutes to 100 °C.

(*a*) Calculate:

(i) the electrical energy used by the wallpaper stripper in 20 minutes;

3

(ii) the starting temperature of the water when the final temperature reaches 100 °C. (Apply the law of conservation of energy and assume no energy losses.)

4

Marks

11. (continued)

In operation it was found that the wallpaper stripper was not 100% efficient.

(*b*) (i) State where energy will be lost.

_____ **1**

(ii) Describe how this loss of energy could be reduced.

_____

_____ **1**

The logic diagram shown in Figure Q11 is used to control the operation of the wallpaper stripper.

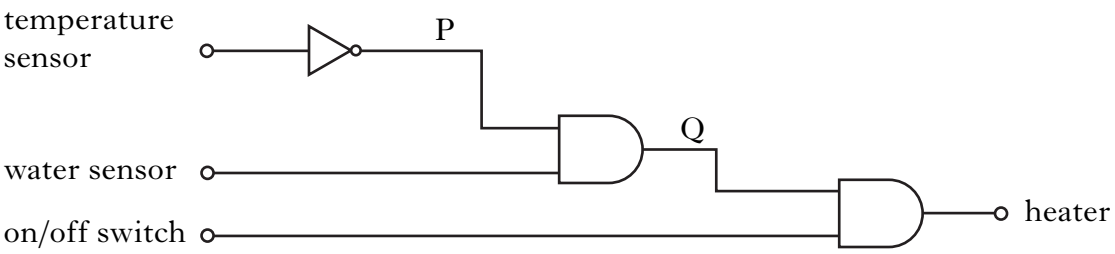


Figure Q11

(*c*) Complete the truth table for the logic diagram shown in Figure Q11.

temperature sensor	water sensor	on/off switch	P	Q	heater
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

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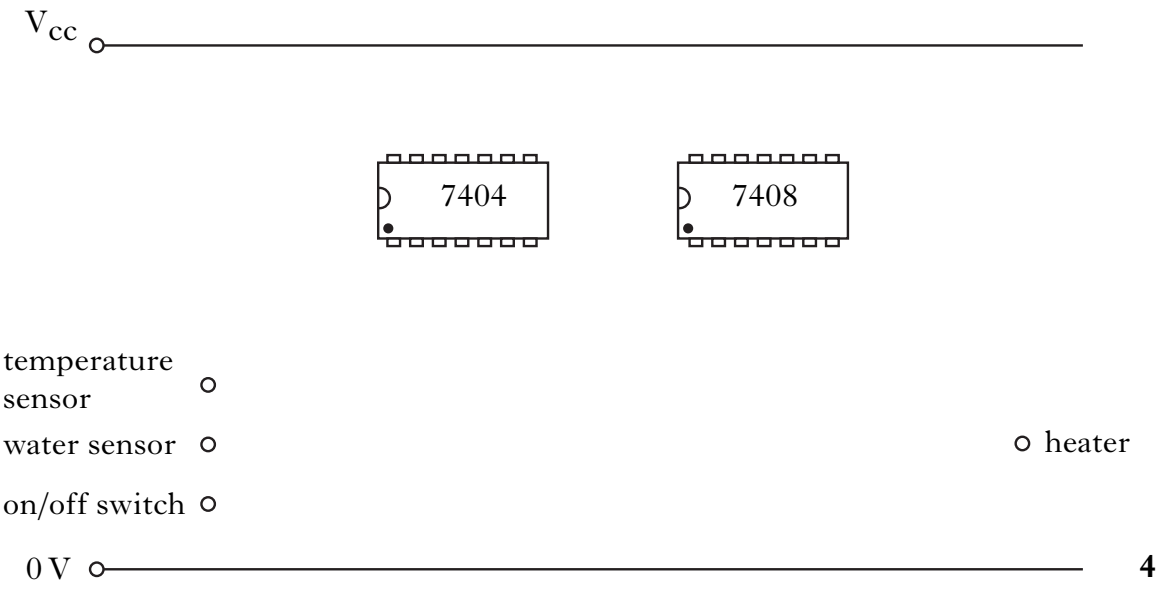
11. (continued)

(*d*) Complete, with reference to the Data Booklet and Figure Q11, the wiring diagram below.



4

(*e*) (i) State the **full** name of the two ICs used in the wiring diagram.

7404 _____

7408 _____ **2**

(ii) State the name of this IC family.

_____ **1**

(iii) State **one** characteristic of this IC family.

_____ **1**

(20)

[*END OF QUESTION PAPER*]

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