

FOR OFFICIAL USE

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Mark

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NATIONAL QUALIFICATIONS 2012

TECHNOLOGICAL
STUDIES
INTERMEDIATE 2



* X 0 3 6 1 1 0 1 *

FRIDAY, 18 MAY
9.00 AM – 11.30 AM

X036/11/01

Fill in these boxes and read what is printed below.

Full name of centre

Town

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Forename(s)

Surname

Number of seat

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Date of birth

Day

Month

Year

Scottish candidate number

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- 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.



* X 0 3 6 1 1 0 1 0 1 *

SECTION A

Attempt ALL questions (Total 60 marks)

1. Figure Q1 shows a simplified sub-system diagram for the control of the light level in an office. A light will turn on if the office is too dark or a window blind will close if it is too bright.

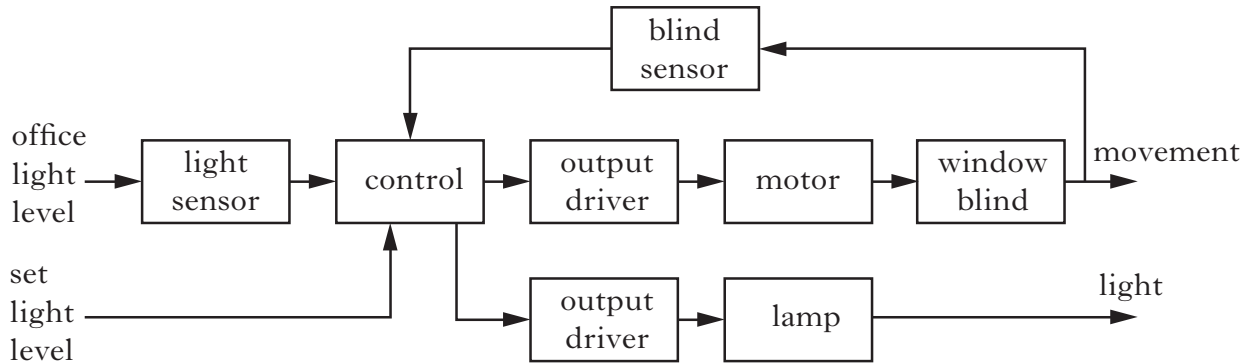


Figure Q1

- (a) (i) Complete the sub-system diagram shown in Figure Q1 by adding the system boundary.
- (ii) Describe why a system boundary should be included in a sub-system diagram.
- (b) Describe, with reference to Figure Q1, the operation of the **window blind**.

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The system in Figure Q1 uses both open and closed loop control.

- (c) (i) State the difference between open and closed loop control.
- (ii) State which of the output transducers is operated using closed loop control.

1

1

(7)



2. The double acting cylinder used to open and close a bus door is controlled by a 5/2, solenoid, spring return valve.

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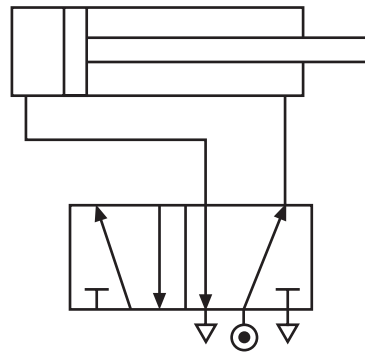


Figure Q2(a)

- (a) (i) Complete Figure Q2(a) by adding the symbols for the solenoid and the spring actuators.
 (ii) Indicate on Figure Q2(a) (with an X) the exhaust port used when the piston **instrokes**.

2

1

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

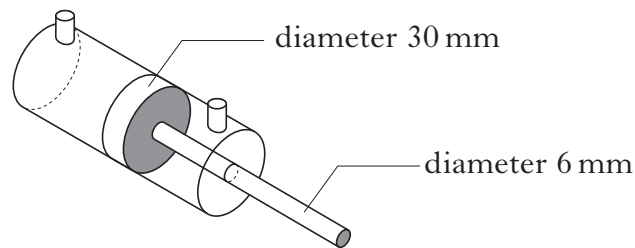


Figure Q2(b)

(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)



* X 0 3 6 1 1 0 1 0 3 *

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3. The wiring diagram for a digital electronic circuit is shown in Figure Q3.

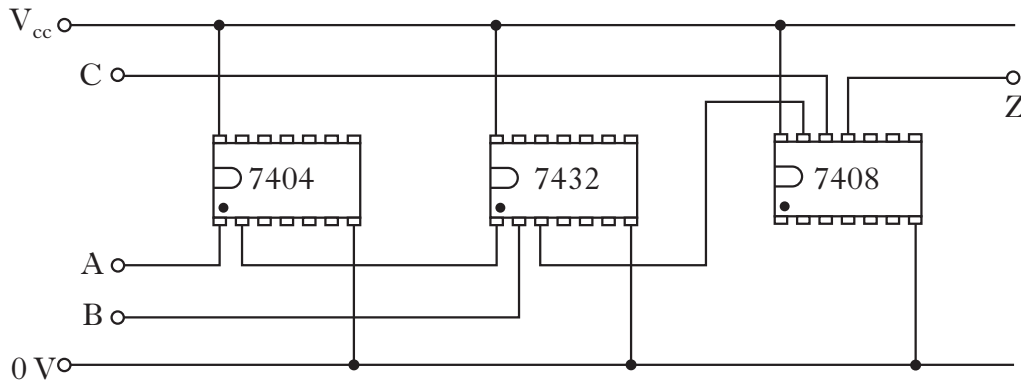


Figure Q3

(a) Complete, with reference to Figure Q3 and the Data Booklet, the logic diagram for the circuit.

A —

B —

— Z

C —

3

(b) State, with reference to the Data Booklet, the **full** name of the following Integrated Circuits.

7400 _____

7402 _____

2



Marks

3. (continued)

The circuit uses the TTL logic family.

(c) State, for this logic family:

(i) its full name;

1

(ii) its operating voltage;

1

(iii) one reason, other than operating voltage, for its use.

1

(8)

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4. Figure Q4 shows an electronic circuit for a garden night light.

Marks

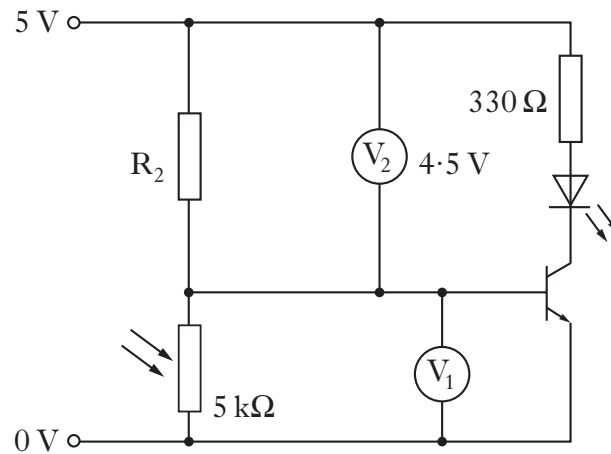


Figure Q4

(a) State, with reference to the Data Booklet, the light level that will produce a resistance of $5\text{ k}\Omega$ in the LDR.

_____ 1

(b) For the conditions shown in Figure Q4:

(i) determine the voltage shown on V_1 ;

1

(ii) calculate the resistance R_2 ;

2

(iii) state if the LED is on or off, and explain why this is the case.

_____ 2



Marks

4. (continued)

- (c) Describe the effect that an increasing light level will have on the resistance of the LDR and the voltage shown on V_1 .

As the light level increases . . .

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5. An 80 kg pole vaulter is travelling at 9 m/s.

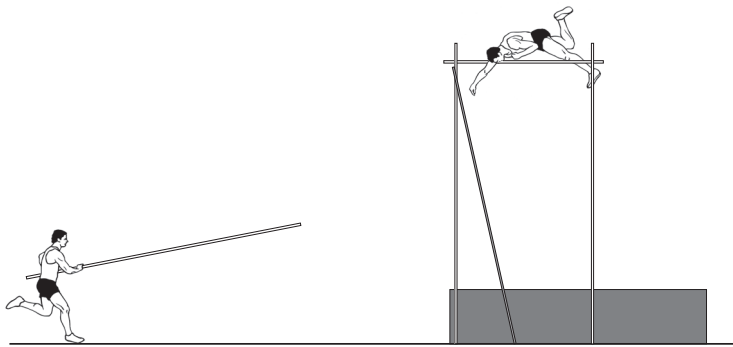


Figure Q5

(a) Calculate the kinetic energy of the pole vaulter.

2

The vaulter must be raised 4 m to clear the bar.

(b) Determine if the vaulter can clear the bar when travelling at 9 m/s immediately before take off. (Apply the law of conservation of energy and assume no energy losses).

4

(c) Describe why, in reality, not all of the kinetic energy of the vaulter is converted to potential energy during the vault.

2
(8)



[Turn over for Question 6 on *Page ten*

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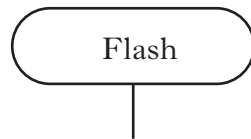
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6. A microcontroller is used to operate the traffic lights at a pedestrian crossing. Part of the sequence to control the lights includes a sub-procedure for the flashing amber light.

The sequence for the 'Flash' sub-procedure is:

- Amber light on for 0.5 seconds
- Amber light off for 0.5 seconds
- Repeat six times

- (a) Draw, with reference to the Data Booklet, the flowchart for the 'Flash' sub-procedure.



5



Marks

6. (continued)

The microcontroller is configured so that only pins 7, 6 and 5 of the I/O port are set as outputs.

(b) Write, with reference to the Data Booklet, the PBASIC command to configure the I/O port.

2
(7)

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7. An electrical circuit is shown in Figure Q7.

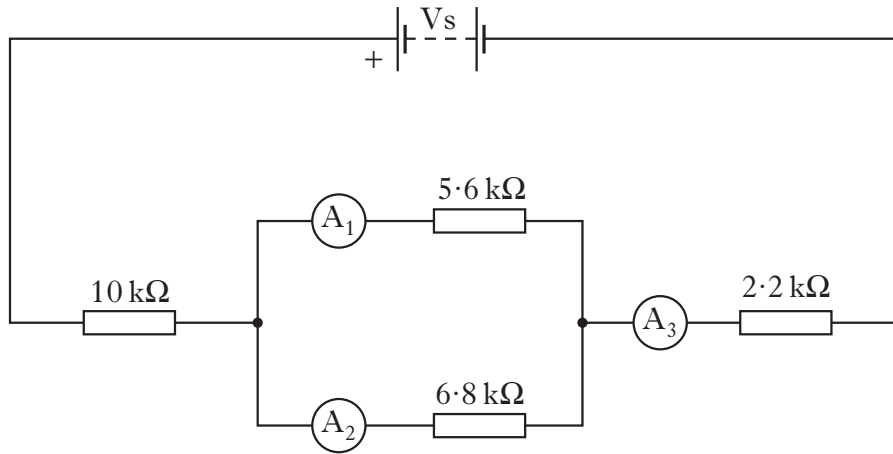


Figure Q7

Calculate, showing all working and units:

(a) (i) the resistance of the parallel arrangement;

(ii) the total circuit resistance.

The current reading on ammeter A_1 is 10 mA.

(b) Calculate the reading on:

(i) ammeter A_2 ;

(ii) ammeter A_3 .

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1
(7)



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8. A vehicle parked on a bridge is shown in Figure Q8.

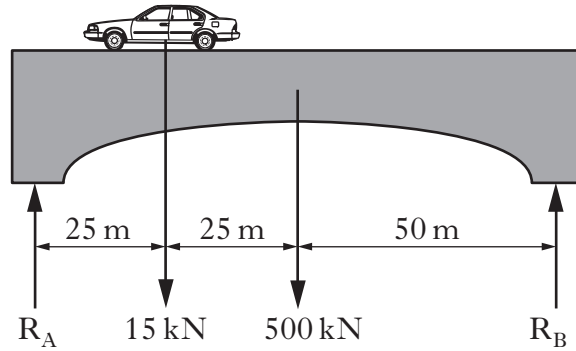


Figure Q8

(a) Draw a free body diagram for the system.

(b) Calculate:

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

(ii) the reaction force R_B .

2

3

2
(7)

[END OF SECTION A]



SECTION B

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Attempt any TWO questions (Total 40 marks)

9. The pneumatic circuit for a door system is shown in Figure Q9(a).

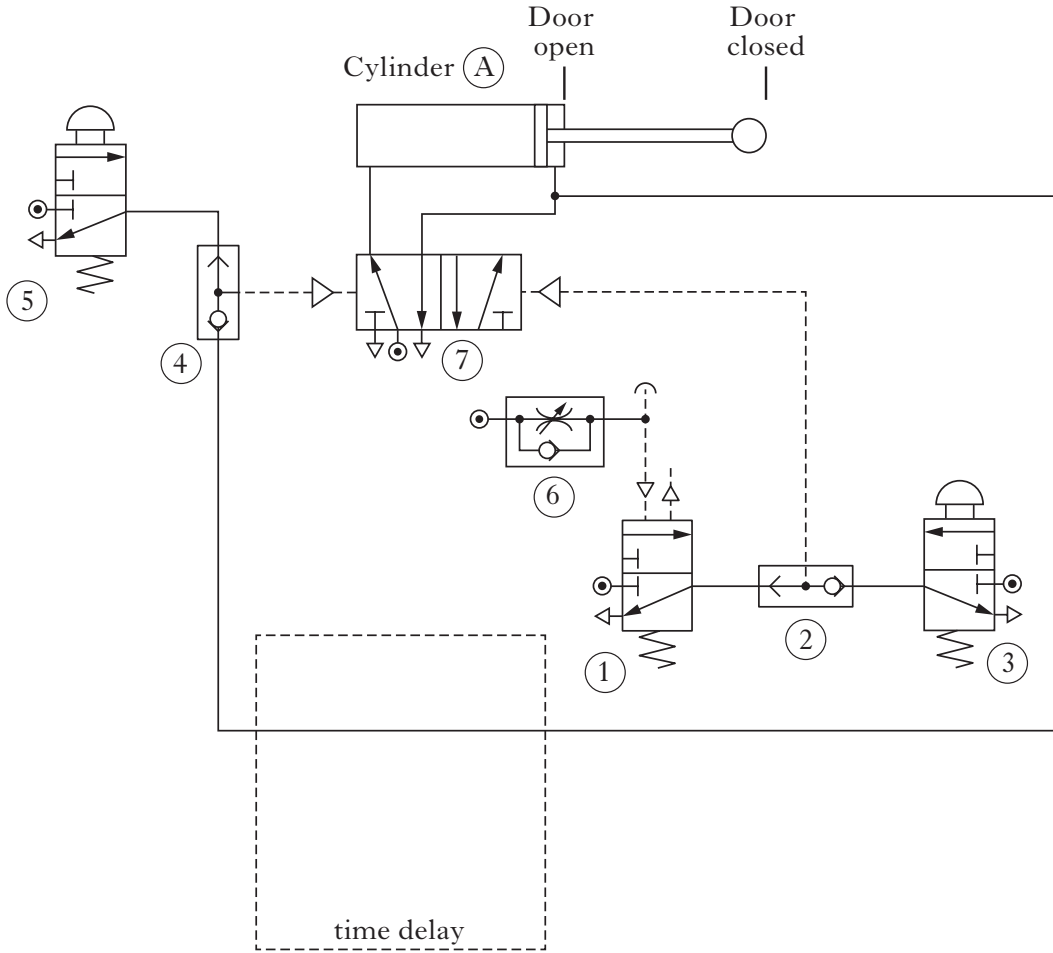


Figure Q9(a)

(a) State the name of component (1).

_____ 1

(b) Draw, in the position shown in Figure Q9(a), the components required to create a controlled time delay when closing the door.

3



9. (continued)

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

When valve (1) is actuated _____

5

The door closes with a force of 40 N.

(d) Calculate the **diameter** of the piston when air is supplied to the cylinder at a pressure of 0.2 N/mm^2 .

3

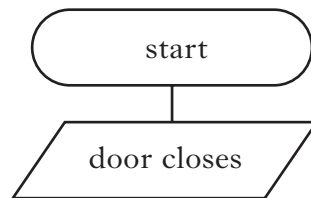


9. (continued)

An alternative door system uses a microcontroller to operate a pneumatic cylinder. The operation of this door system is given below.

- The door closes.
- When a person is sensed **or** a door switch is activated the door opens.
- The door remains open for 15 seconds.
- The sequence repeats.

(e) Complete, with reference to the Data Booklet, the flowchart for this door system.



6



Marks

9. (continued)

A simplified block diagram for the microcontroller used is shown in Figure Q9(b).

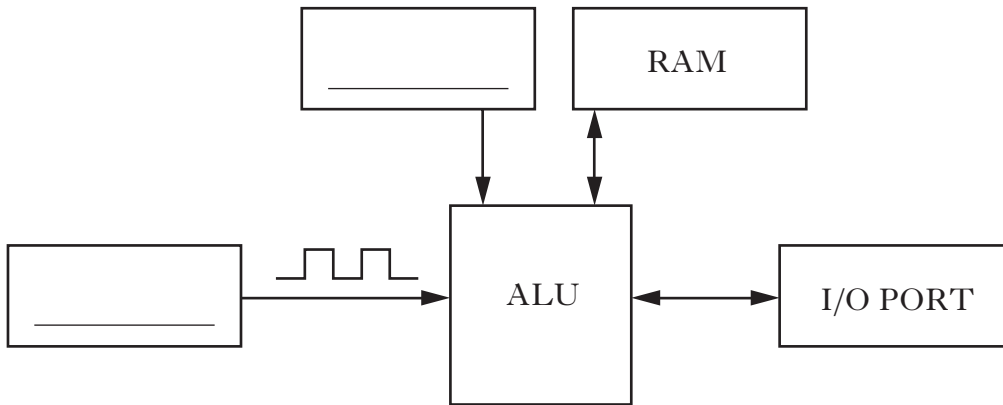


Figure Q9(b)

(f) Complete the microcontroller diagram shown in Figure Q9(b).

2
(20)

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10. A circuit used in a fridge is shown in Figure Q10.

Marks

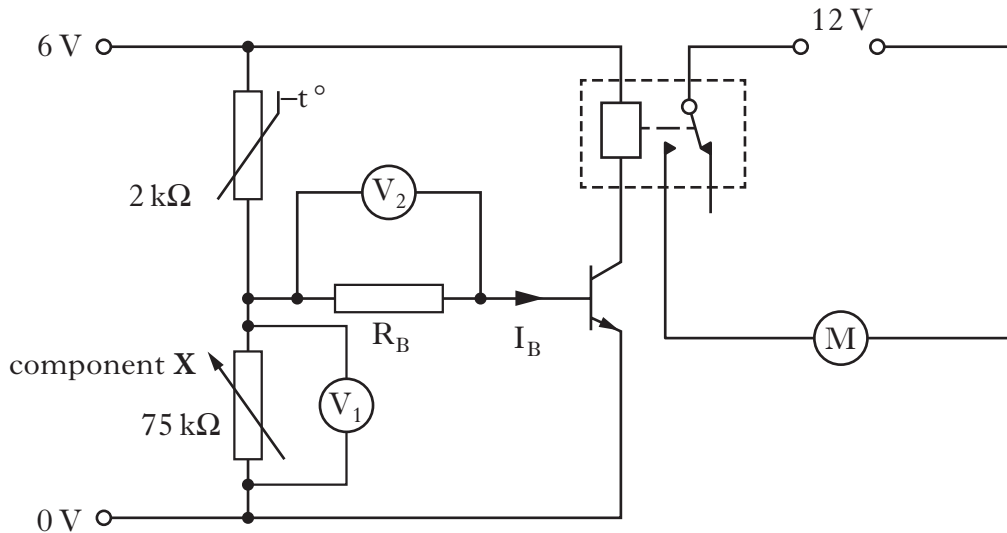


Figure Q10

(a) State, with reference to the Data Booklet, the temperature when a type 1 thermistor has a resistance of $2\text{ k}\Omega$.

_____ 1

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

_____ 1

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

_____ 1

(c) Calculate the voltage shown on V_1 .

2

When the temperature drops, $V_1 = 1.6\text{ V}$ and the transistor saturates.

(d) Calculate the voltage shown on V_2 .

2



10. (continued)

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The relay operates at 6 V, 0.2 A.

(e) Calculate the base current (I_B) if the transistor gain (h_{FE}) is 100.

2

(f) Complete the circuit shown in Figure Q10 to include the symbol for a diode to protect the transistor.

2

The motor operates for 30 minutes at 12 V, 10 A.

(g) Calculate:

(i) the electrical energy used by the motor;

3

(ii) the efficiency of the motor when the output energy is 190 kJ.

2

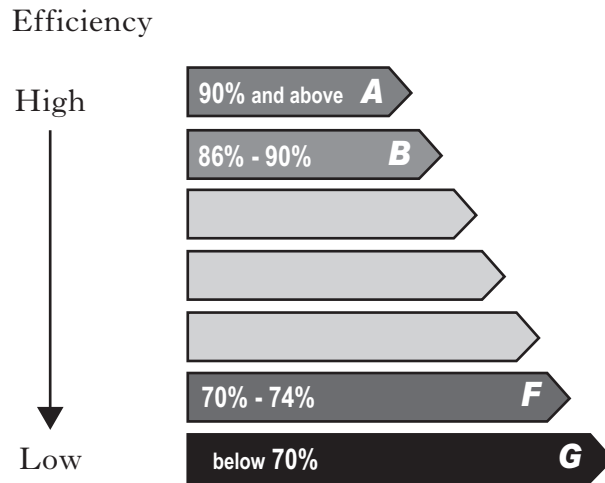
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10. (continued)

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Modern fridges are graded for their energy efficiency as shown below.



(h) Describe **two** ways in which a fridge could be made more energy efficient.

1 _____

 2 _____

2

(i) (i) State **one renewable** energy source that could be used to produce electricity.

1

(ii) Describe **one** disadvantage, other than cost, of using the energy source stated in (i)(i).

1

(20)

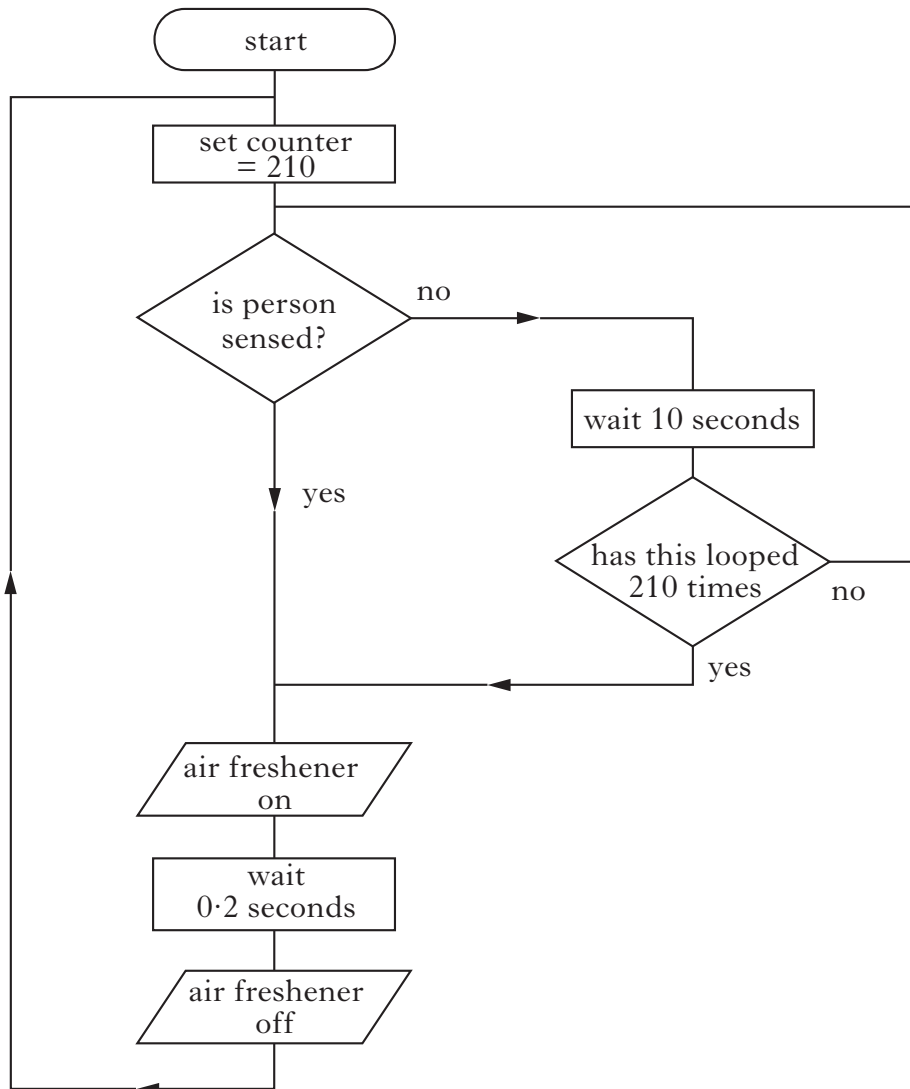


[Turn over for Question 11 on *Page twenty-two*

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11. A microcontroller is used to operate an air freshener. The system will automatically activate the air freshener after a set period of time or when a person is sensed. The flowchart and the input and output connections are shown in Figure Q11(a).



input connection	pin	output connection
	7	air freshener
	6	
	5	
	4	
	3	
person sensor	2	
	1	
	0	

Figure Q11(a)



11. (continued)

Marks

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

```

init:      let dirs = %10000000      'set pin 7 as an output
          symbol counter = b0      'set b0 as counter

main:

```

8

(b) Calculate, with reference to Figure Q11(a), the time taken before the air freshener will work when a person is **not** sensed.

1

The 'counter' data is stored in the microcontroller.

(c) (i) State the name of the memory type that is used.

1

(ii) Explain why this type of memory would not be used to store the microcontroller program.

1



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11. (continued)

The logic diagram for an alternative air freshener is shown in Figure Q11(b).

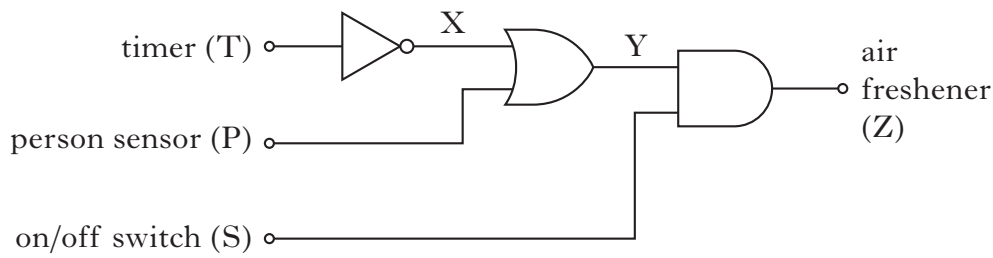


Figure Q11(b)

(d) State, with reference to Figure Q11(b), the Boolean expression for the air freshener (Z) in terms of T, P and S.

Z = _____

3

(e) Complete the truth table for the logic diagram shown in Figure Q11(b).

S	P (1 = person sensed)	T (0 = timer on)	X	Y	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

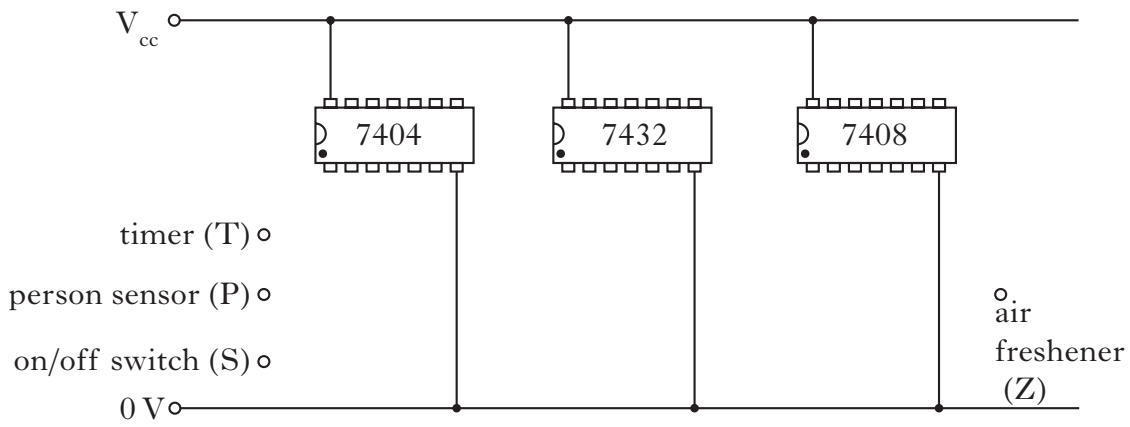


11. (continued)

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



3
(20)

[END OF SECTION B]

[END OF QUESTION PAPER]



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