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Centre Number					Candidate Number				
Candidate Signature									

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General Certificate of Secondary Education  
June 2004

**ELECTRONICS**  
**Higher Tier**

**3432/H**



Wednesday 9 June 2004 1.30 pm to 3.30 pm

**H**

**In addition to this paper you will require.**

- a pencil and a ruler;
- a calculator.

Time allowed: 2 hours

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Show the working of your calculations.

**Information**

- The maximum mark for this paper is 150.
- Mark allocations are shown in brackets.
- A list of formulae and other information, which you may wish to use in your answers, is provided on page 2.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

## Information Sheet

The following information may be useful in answering the questions.

### 1. Power

Power = voltage x current;  $P = VI$

### 2. Amplifiers

Voltage gain  $G_v = \frac{V_{OUT}}{V_{IN}}$

### 3. Resistor colour code

The colours in the resistor colour code correspond to the following values.

BLACK	0	GREEN	5
BROWN	1	BLUE	6
RED	2	VIOLET	7
ORANGE	3	GREY	8
YELLOW	4	WHITE	9

The fourth band colour gives the tolerance.

GOLD  $\pm 5\%$       SILVER  $\pm 10\%$       No fourth band  $\pm 20\%$

### 4. Resistor printed code (BS 1852)

R means  $\times 1$

K means  $\times 1000$

M means  $\times 1\,000\,000$

Position of letter gives the decimal point.

Tolerances are indicated by adding a letter at the end.

J  $\pm 5\%$       K  $\pm 10\%$       M  $\pm 20\%$

e.g. 5K6J = 5.6 k $\Omega$   $\pm 5\%$

### 5. Preferred values for resistors (E24 SERIES)

1.0 1.1 1.2 1.3 1.5 1.6 1.8 2.0 2.2 2.4 2.7 3.0 3.3 3.6 3.9 4.3 4.7 5.1 5.6 6.2 6.8 7.5 8.2 9.1  
and multiples of ten.

### 6. Resistance = $\frac{\text{voltage}}{\text{current}}$ ; $R = \frac{V}{I}$

### 7. Effective resistance, R, of resistors in series is given by $R = R_1 + R_2 + R_3$

### 8. Effective resistance, R, of two resistors $R_1$ and $R_2$ in parallel is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

### 9. A.C. waveforms

(a) Frequency of waveform =  $\frac{1}{\text{time period}}$ ;  $f = \frac{1}{T}$

(b) peak value = 1.4 x rms value

### 10. Astable and monostable generators using 555 timers

(a) Monostable mode, time period  $T = 1.1 R_1 \times C_1$

(b) Astable mode, time period  $T = \frac{(R_1 + 2R_2) C_1}{1.44}$

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

**1** Name the device or component described by each statement below.

- (a) This component can conduct current in one direction only.

.....  
(1 mark)

- (b) This component has a resistance which decreases as its temperature increases.

.....  
(1 mark)

- (c) This device emits sound waves of the same frequency as the signal supplied to it.

.....  
(1 mark)

- (d) This device contains an electromagnet and can be used to switch large currents.

.....  
(1 mark)

- (e) This device provides a stable voltage even when the current drawn from it changes.

.....  
(1 mark)

5

**TURN OVER FOR THE NEXT QUESTION**

**Turn over ▶**

2 These are the sub-systems of a radio receiver:

**aerial**

**rf tuned circuit**

**demodulator**

**af amplifier**

**loudspeaker**

Choose from the list above the name of the sub-system that:

- (a) recovers the audio signal from the carrier wave;

.....  
(1 mark)

- (b) selects one particular frequency from all those received;

.....  
(1 mark)

- (c) produces sound waves;

.....  
(1 mark)

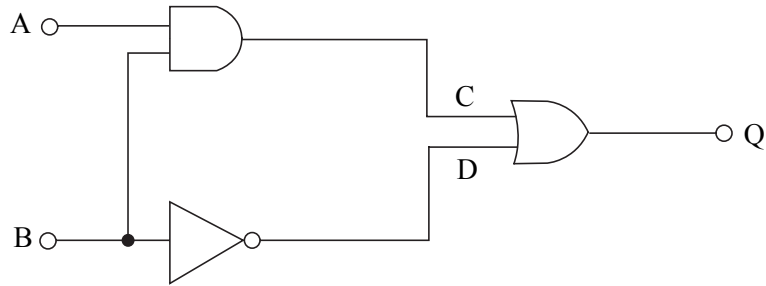
- (d) increases the amplitude of the audio signal;

.....  
(1 mark)

- (e) generates small voltages at radio frequencies.

.....  
(1 mark)

3 A logic diagram is shown below.



(a) Complete the truth table below to show the operation of the circuit.

A	B	C	D	Q
0	0			
0	1			
1	0			
1	1			

(4 marks)

(b) Input A is from a door sensor, which gives a logic 1 when the door is closed and a logic 0 when the door is opened.

Input B is from a light sensor that gives a logic 1 in the dark and a logic 0 in the light.

(i) Name the component that would be suitable to use as a light sensor.

.....

(ii) Name the component that would be suitable to use as a door sensor.

.....

(iii) State the combination of physical inputs that will make Q logic 0.

..... and .....

(4 marks)

QUESTION 3 CONTINUES ON THE NEXT PAGE

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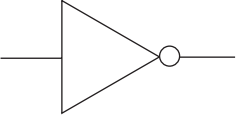
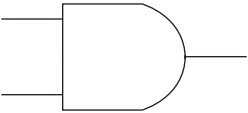
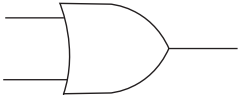
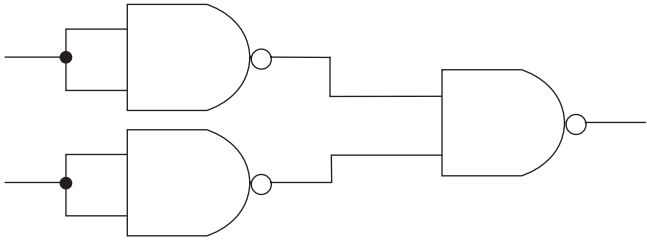
- (c) Three different types of logic gate are used in the design of the logic circuit and so three separate logic ICs would be required. This can be reduced to one IC by re-designing the circuit.

It was decided to re-design the logic circuit using NAND gates only.

- (i) Name the only other type of gate that could be used to re-design the logic circuit.

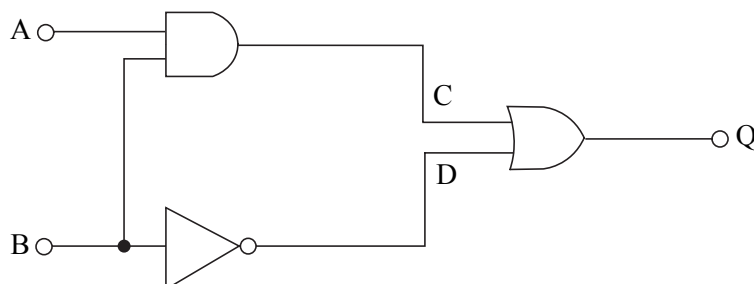
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- (ii) Complete the table below to show how each required gate can be made from NAND gates.

required gate	NAND gate equivalent
	
	
	

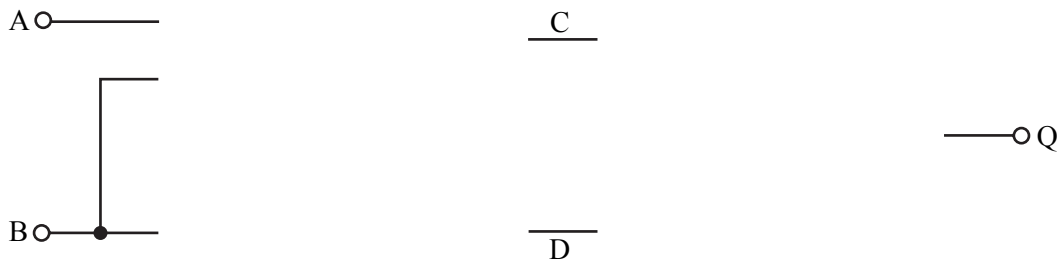
(4 marks)

- (d) The original logic diagram is shown below.



Re-draw the original logic diagram shown on **page 6** using the NAND gate equivalents from the table in part (c)(ii).

(i) Complete the diagram below.



(ii) There should be two places on the diagram where a NAND gate used as an inverter is followed immediately by another NAND gate inverter.

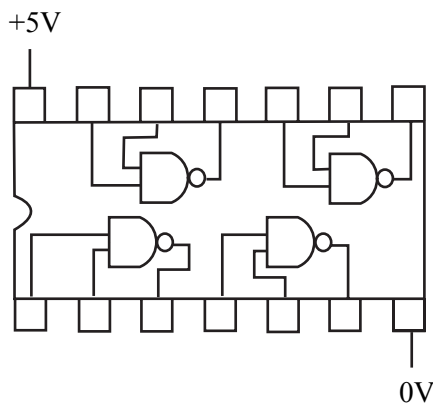
In these cases they could each be replaced by a wire link. Draw rings around each pair of gates that could be replaced by wires.

(iii) In the space below draw the final circuit, which uses only two NAND gates.



(13 marks)

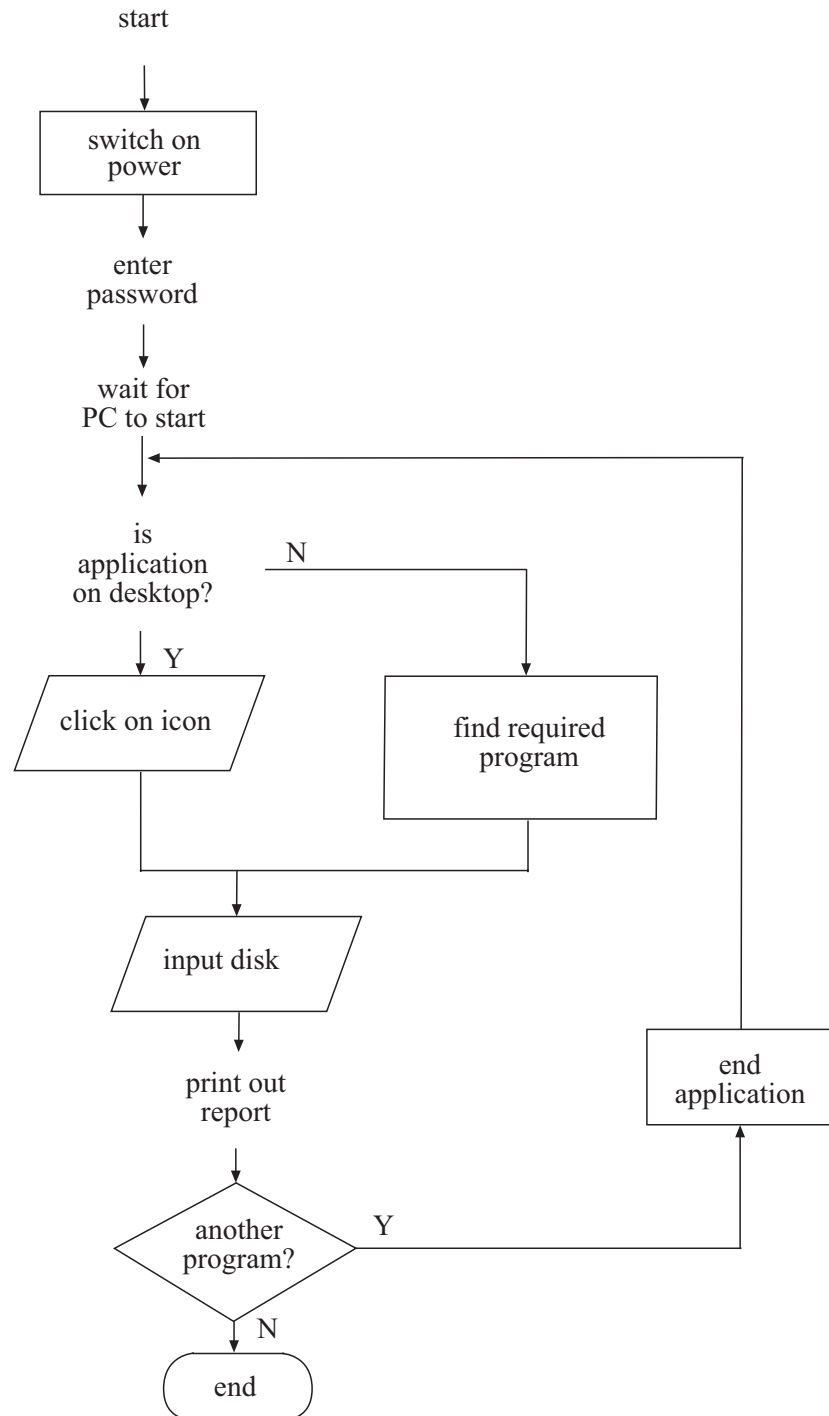
(e) The logic gate IC has four NAND gates. On the diagram below draw all the connections, label inputs and output to show a design for construction of the final circuit using gates on one side of the IC.



(5 marks)

Turn over ▶

4 This flowchart is for printing out a piece of work from a floppy disk using a computer.



(a) Draw the correct flowchart symbols where they are missing on the diagram. (5 marks)

(b) Label on the flowchart:    an input box            an output box            a compare box  
   a process box            a loop

(5 marks)



- (c) Draw in the space below a flowchart for switching on a CD player, reading the number of tracks, selecting a track and playing it. Include a loop so that another track can be chosen and played. Complete your flowchart by ejecting the CD and switching off the CD player. You may use the flowchart on **page 8** as a guide.

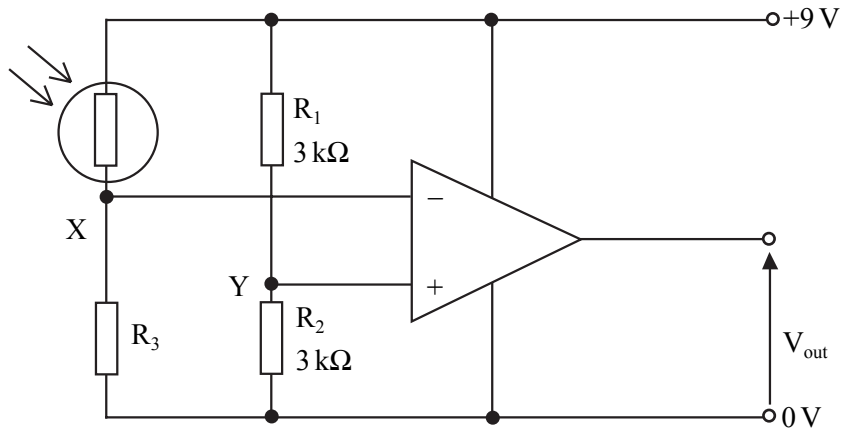
(10 marks)

20

Turn over ►

- 5 A school librarian asks an electronics student to build a circuit to count the number of people entering the library.

The student places a light beam across the entrance. The beam falls on a light dependent resistor and is broken when a person walks past. He uses this circuit as the sensor.



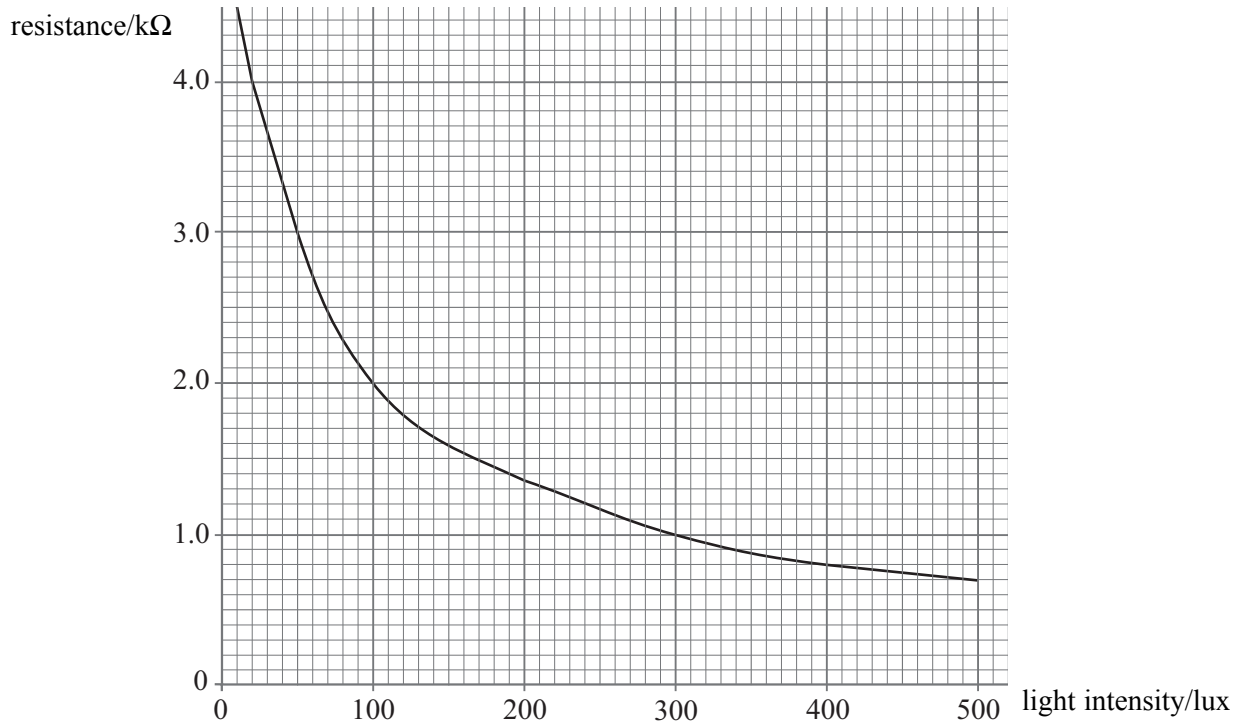
- (a) Calculate the voltage at Y.

.....

.....

*(3 marks)*

(b) The resistance of the light dependent resistor varies as shown below.



(i) In a test the student finds that the light intensity is 50 lux when the beam is broken. From the graph, find the resistance of the light dependent resistor at 50 lux.

.....

(ii) The light intensity is 250 lux when the beam is not broken. From the graph, find the resistance of the light dependent resistor at 250 lux.

.....

(iii) If  $V_{out}$  is to be at a low voltage, how should the voltage at X compare with the voltage at Y?

.....

(iv) The student decides that the voltage  $V_{out}$  should go high at a light level of 100 lux. State the value  $R_3$  should have. Explain your answer.

.....

.....

(v) Why would it be an advantage to make  $R_3$  a variable resistor?

.....

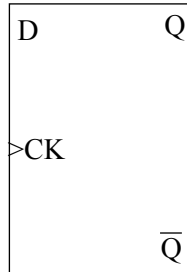
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(7 marks)

QUESTION 5 CONTINUES ON THE NEXT PAGE

Turn over ►

- (c) (i) The student decides to use four D-type flip-flops to make a counter. Complete the diagram below to show how a D-type flip-flop should be connected to make a divide by two circuit. Label the input and the output.

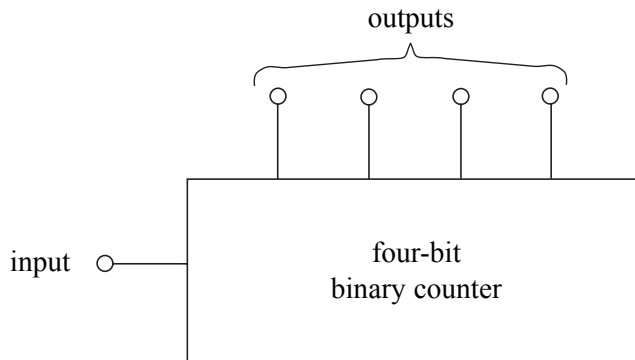


- (ii) Describe how **two** of these circuits should be connected to make a divide by four circuit.

.....  
 .....

(6 marks)

- (d)



- (i) The counter counts in binary. Write the binary number for 7.

.....

- (ii) Write the decimal number for binary 1010.

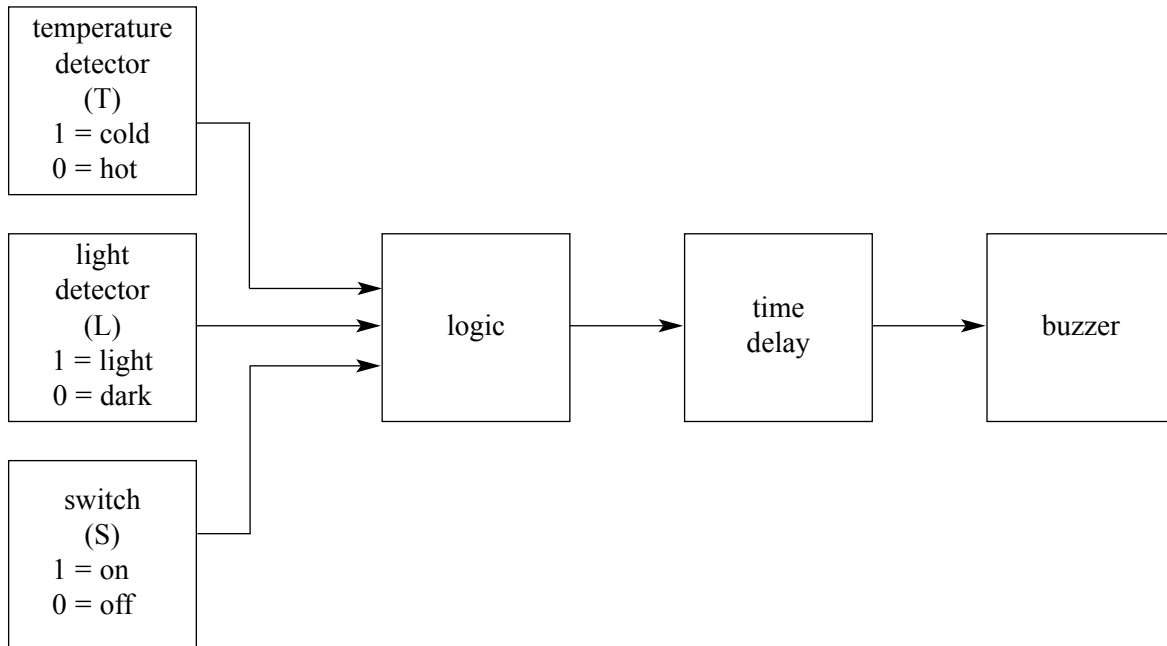
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- (iii) What is the largest number this counter can record?

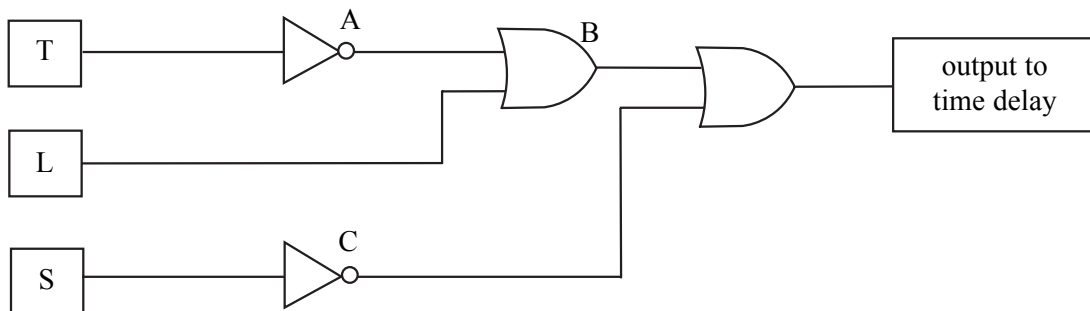
.....

(3 marks)

- 6 A very keen gardener builds an alarm to wake him when there is a frost at night. There is a switch to turn off the alarm if he does not want to be woken.



This network of gates is used for the logic.



- (a) A low voltage output is required to trigger the time delay. Complete the truth table below for the network of gates.

T	L	S	A	B	C	output
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

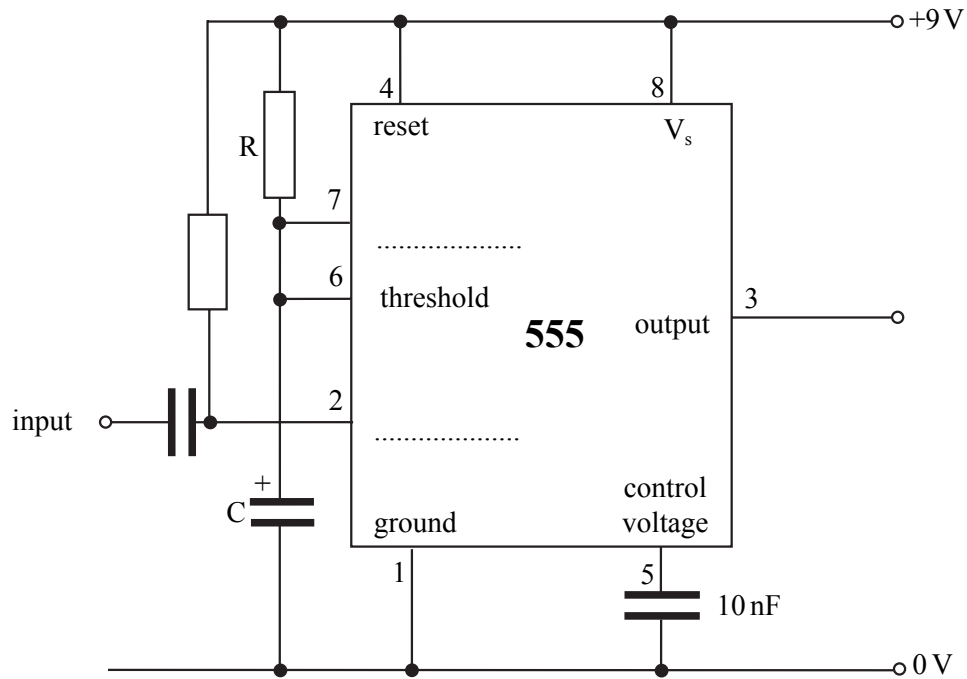
(6 marks)

QUESTION 6 CONTINUES ON THE NEXT PAGE

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(b) The time delay is made using a 555 timer as a monostable.

(i) Label the **two** missing names on the connections to this 555 timer.





(ii) Explain what happens to the voltage at the output of this circuit when the input voltage falls to 0 V.

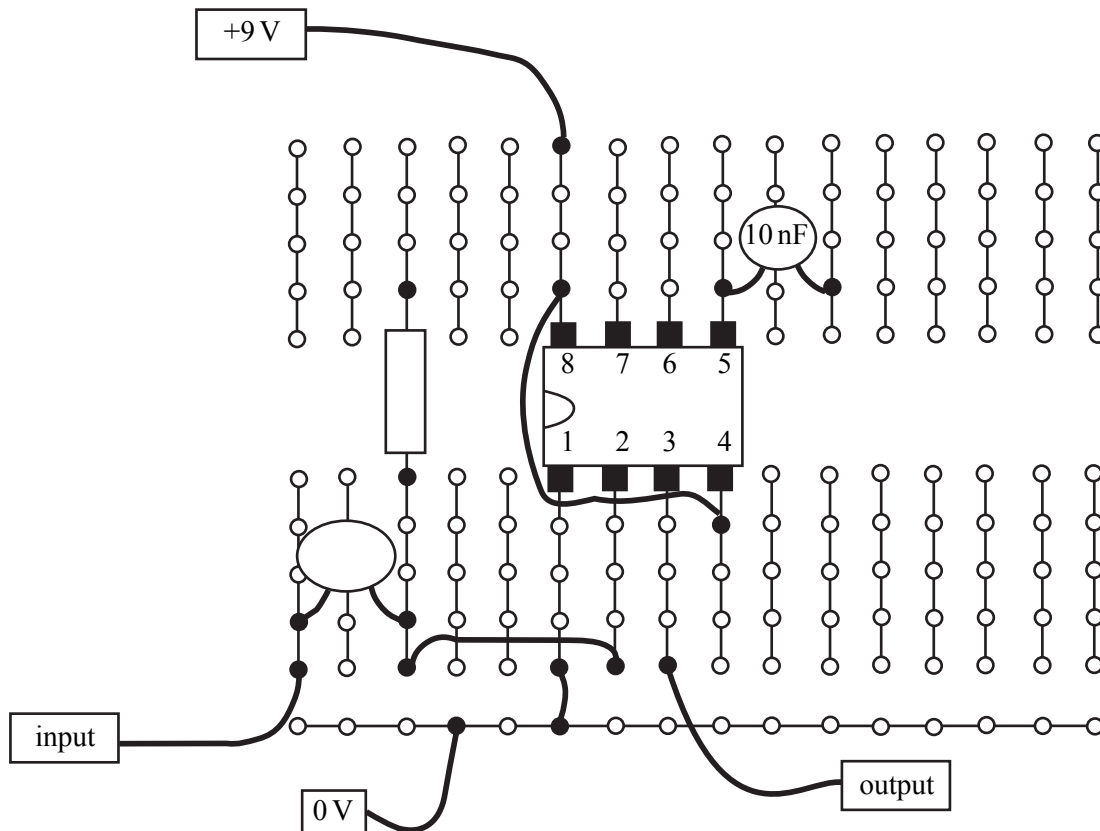
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.....

(4 marks)

- (iii) The monostable is made on prototype board. Complete the layout by adding:  
 a capacitor ,  
 a resistor ,  
 and the wire links needed.

The pin connection numbers for a 555 timer are shown on **page 14** in part (b)(i).



(5 marks)

15

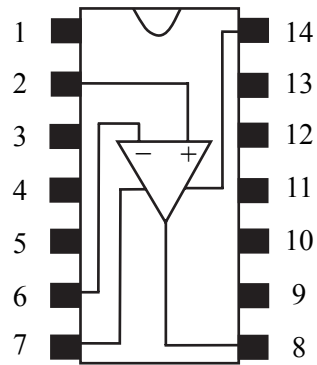
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**NO QUESTIONS APPEAR ON THIS PAGE**



7 A student is investigating an audio amplifier. The amplifier circuit uses an IC type LM380.

(a) Some of the pin connections for the IC are shown below.



- (i) Which pin is the output of the IC?.....
- (ii) Which pins are the signal inputs to the IC?.....
- (iii) Which pins should the power supply be connected to?.....

(3 marks)

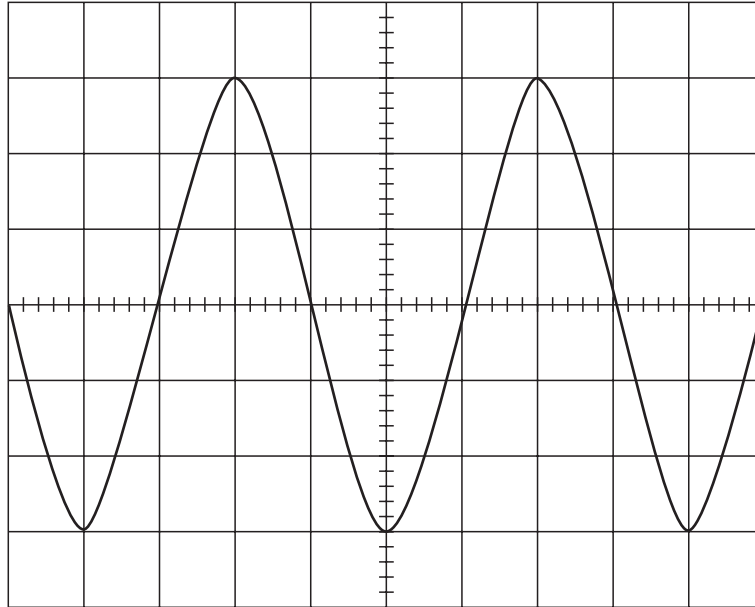
**QUESTION 7 CONTINUES ON THE NEXT PAGE**

**Turn over ▶**

- (b) The student connects both a signal generator and an oscilloscope to the input of the amplifier circuit. The following trace was produced:

The Y sensitivity is set to 0.1 V per division.

The timebase is set to 2 ms per division.



- (i) Calculate the time period of the input signal.

.....

.....

- (ii) Calculate the frequency of the input signal.

.....

.....

- (iii) What is the amplitude of the input signal?

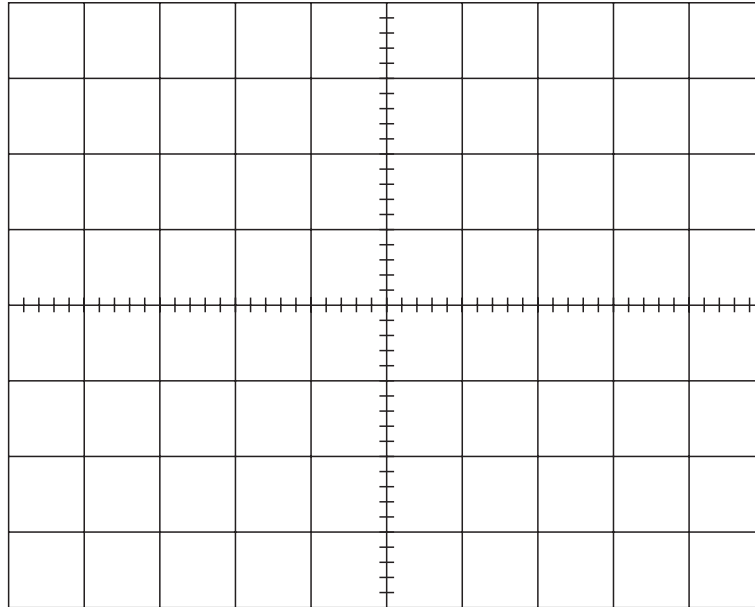
.....

- (iv) The amplifier circuit has a gain of 20. Calculate the amplitude of the output voltage.

.....

.....

- (v) With the signal generator still connected to the input the student now moves the oscilloscope connections to the output of the amplifier circuit. The student adjusts the Y sensitivity to 2 V per division and leaves the timebase settings as before. Draw the appearance of the trace now seen on the oscilloscope.



(13 marks)

- (c) The student connects a loudspeaker with a resistance of  $8\ \Omega$  to the output and adjusts the signal generator so that the amplitude of the output voltage is 3 V. Calculate the peak output power.

.....  
.....

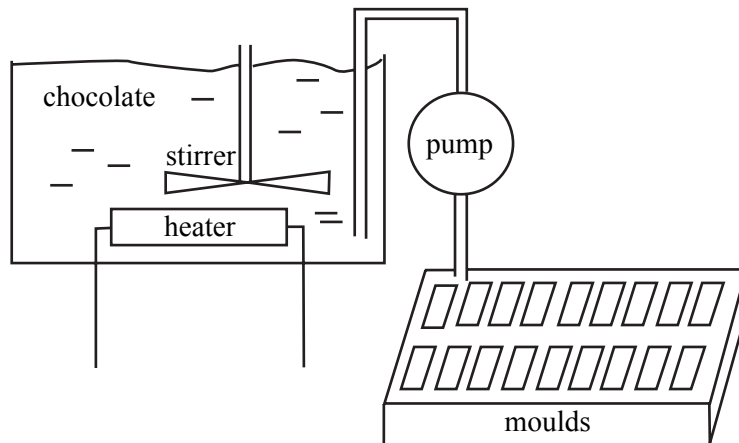
(3 marks)

- (d) The amplifier circuit has a bandwidth of 10 kHz. Describe **two** ways the trace on the oscilloscope would change as the frequency of the signal generator is increased slowly to 10 kHz.

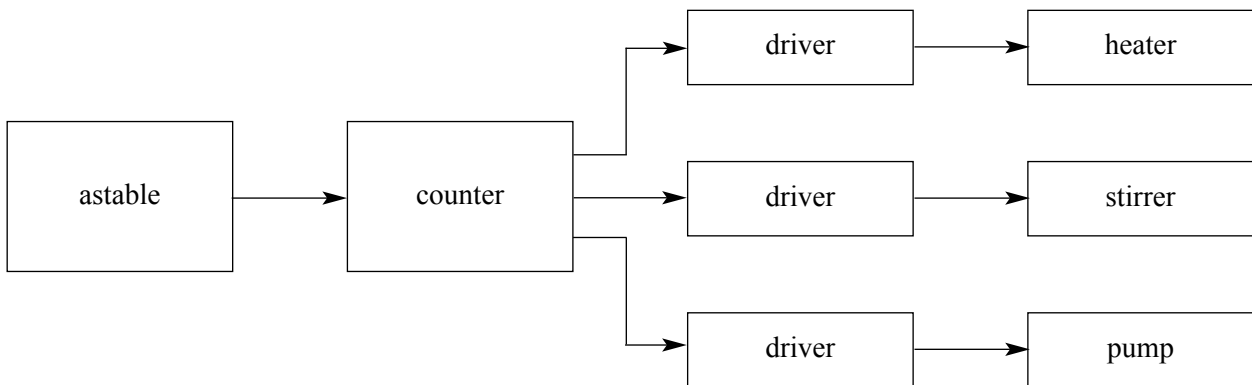
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.....  
.....  
.....

(2 marks)

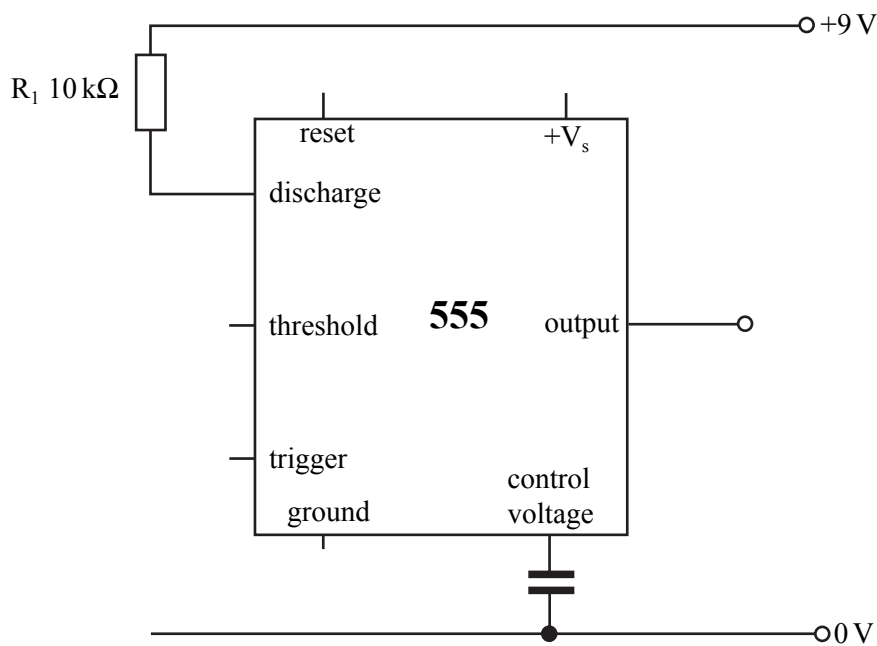
8 The equipment used in a factory to melt, stir and pump chocolate into moulds is shown below.



The heater, stirrer and pump are controlled electronically by this system.



(a) The astable uses a 555 timer IC to produce pulses. Complete the diagram below to show how the 555 timer should be connected. Add a resistor, a capacitor and the wire links needed.



(6 marks)

- (b) Show that the time period of the pulses produced by the astable will be approximately 30 s if the value of the timing capacitor is  $47 \mu\text{F}$  and the value of  $R_2$  is  $470 \text{ k}\Omega$ .

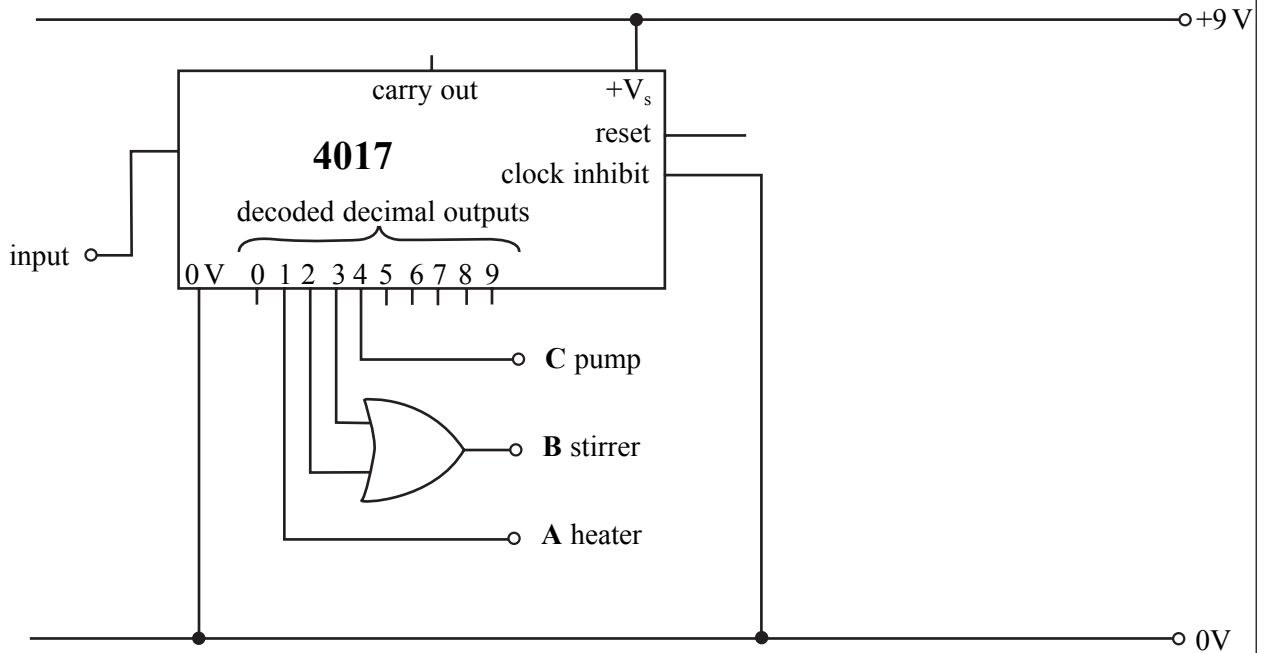
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.....

.....

(3 marks)

- (c) A 4017 IC connected as below is used as the counter.



- (i) Add to the diagram a resistor and a push switch which could be used to provide a high level voltage to reset the 4017 type counter.
- (ii) Explain why the resistor is needed as well as the switch.

.....

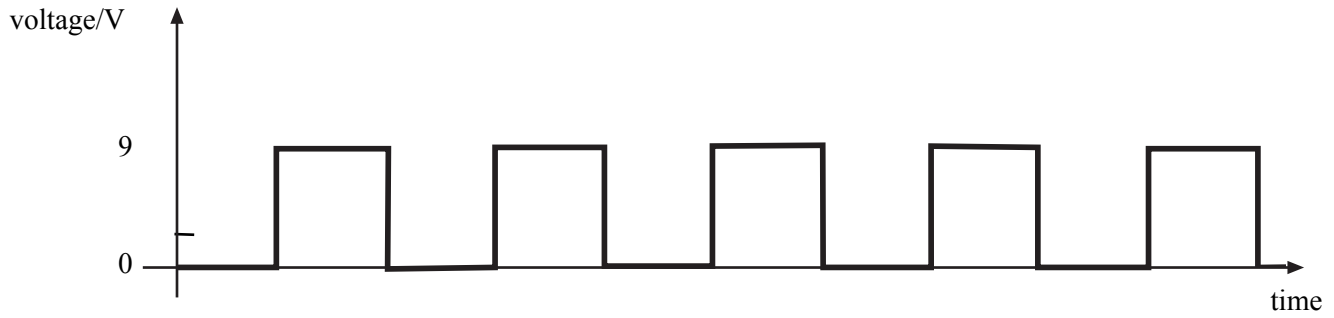
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(4 marks)

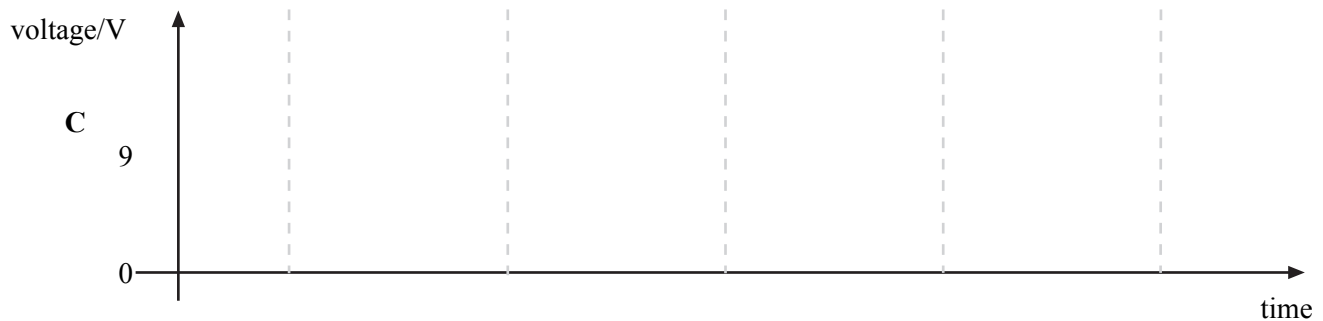
**QUESTION 8 CONTINUES ON THE NEXT PAGE**

**Turn over ▶**

- (d) (i) The 4017 counter is reset and the 555 timer is switched on and produces the pulses shown:



Complete the timing diagrams for the points **A**, **B** and **C** as shown in the diagram on **page 21**.



- (ii) The heater, stirrer and pump are each switched on when a high level voltage from the counter circuit is supplied to their driver circuits. Explain the sequence of events which happens as the 555 produces the pulses shown on **page 22**.

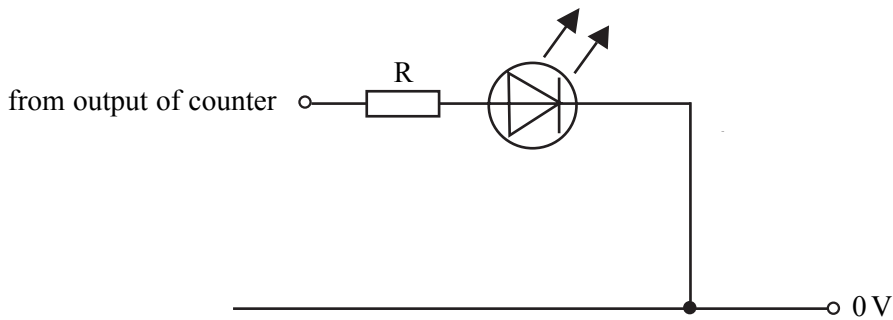
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(9 marks)

- (e) It is decided to add an LED to the circuit to light up as soon as the pump is switched off.



- (i) Which output of the counter should the LED be connected to?
- .....
- (ii) For how long will the LED stay lit?
- .....
- (iii) The LED requires a resistor, R, in series with it. The LED has 2 V across it when it is conducting. Calculate the voltage across the resistor when the counter output is 9 V.
- .....
- (iv) The LED must not carry more than 20 mA of current. Calculate the value of the series resistor required to limit the current to this value.
- .....
- .....

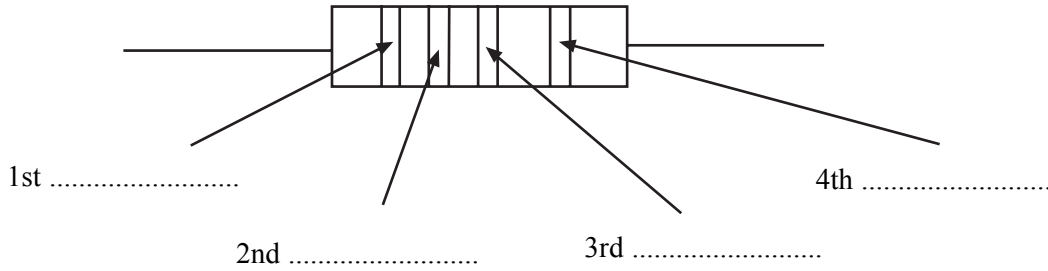
**QUESTION 8 CONTINUES ON THE NEXT PAGE**

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(v) What preferred valued of resistor should be used?

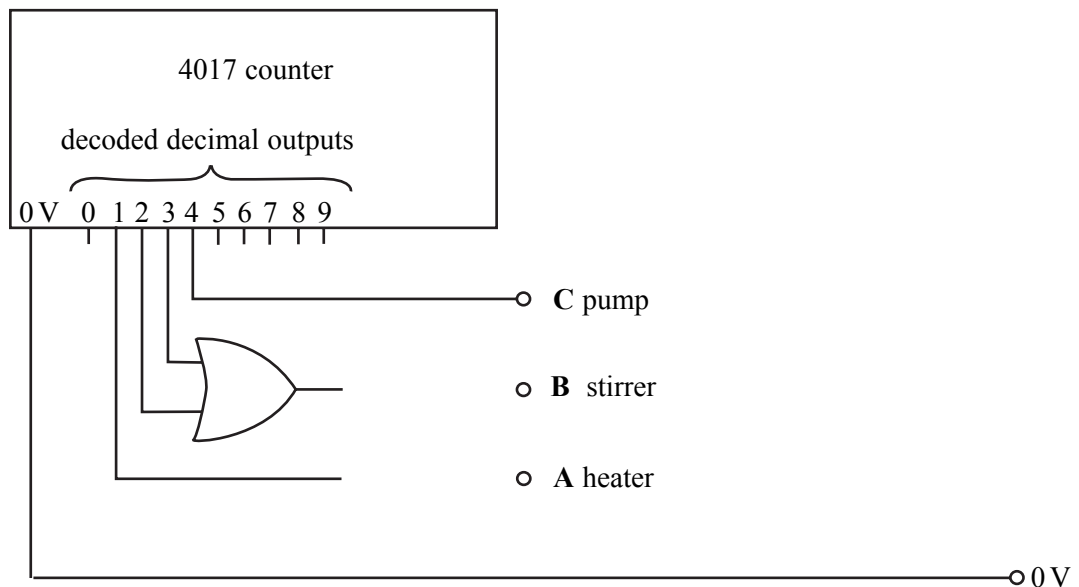
.....

(vi) Label the coloured bands on this resistor assuming it has a tolerance of 5%.



(10 marks)

(f) The diagram below shows the output part of the counter circuit. Show on this diagram how a logic gate can be added to the circuit so that the heater will remain on while the stirrer is operating but still turn off when the pump starts.



(3 marks)

**END OF QUESTIONS**