




<b>Topic</b>	<b>2017 SQP</b>	<b>2018</b>	<b>2019</b>
Circuit Symbols and Functions	1a	1a	1a
Resistor Values	1b	1b	1b
Cable & Wiring	2	2	2b
Series/Parallel Circuits	3	3	3, 5b
Logic Gates	4	4	4
Logic Testing		5	
AC/DC	5	6	6
Electromagnetism			2a
Switching Circuits	6b, 7b	7a	
Voltage Dividers	7a	7b	
Special Circuits (Bi-stable, 555, Comparator)			7
Circuit Simulation/Testing	6a,c		8a
Safety	9a		
Circuit Errors		8	5a, 8b
Circuit Cost		9	
Block Diagrams	8	10	9
Circuit/Layout Diagrams	9b	11	10

Total marks — 60  
Attempt ALL questions

1. (a) The table gives information about some circuit components. Some of the boxes have been left blank.

Complete the table for the missing entries.

3

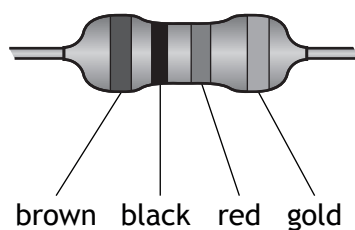
<i>Name</i>	<i>Symbol</i>	<i>Function</i>
resistor		limits current, drops voltage
		stores charge
bipolar transistor		electronic switch
diode		



\* S 8 6 0 7 5 0 1 0 2 \*

## 1. (continued)

(b) The diagram below shows the colour coding for a resistor.



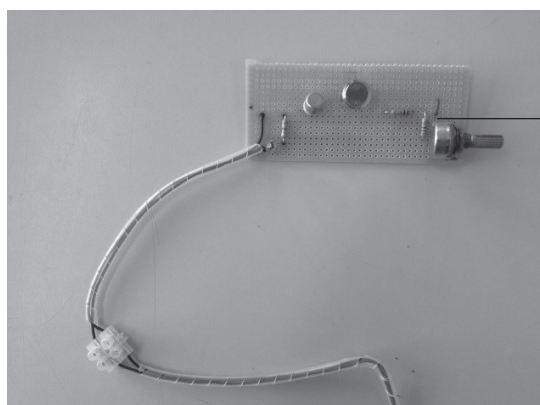
Using information in the data sheet:

- |   |   |
|---|---|
| (i) determine the resistance of the resistor;                       | 1 |
| (ii) state the tolerance in the resistance of the resistor;         | 1 |
| (iii) determine the maximum and minimum resistance of the resistor. | 2 |

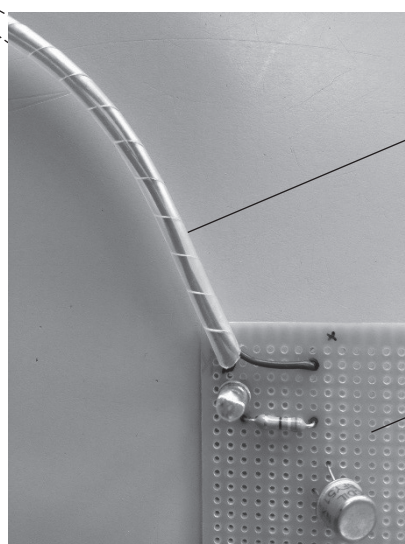
[Turn over



2. The photographs show the wiring connections between a process board and an output board for a circuit.



process  
board



wiring

output  
board

- (a) Name the type of wiring shown which connects the two boards.

1

- (b) Describe how a continuity tester could be used to ensure good connections between the boards.

2



## 2. (continued)

- (c) State two methods that could be used to identify the correct wiring between the boards.

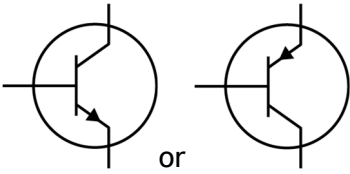
2

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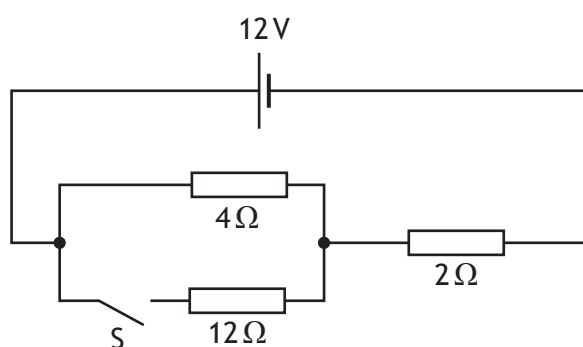


\* S 8 6 0 7 5 0 1 0 5 \*

## Marking instructions for each question

Question			Answer	Max mark	Additional guidance
1.	(a)		<div>capacitor 1</div> <div>  <div>or 1</div> </div> <div>allows current to flow in only one direction or similar 1</div>	3	Accept symbol for npn or pnp transistor (with or without circle).
	(b)	(i)	1000 $\Omega$ or 1 k $\Omega$ or 1k or 1k0	1	
		(ii)	5%	1	Percentage sign is required.
		(iii)	<div>950 <math>\Omega</math> or 950R 1</div> <div>1050 <math>\Omega</math> or 1k05 1</div>	2	If unit omitted award a maximum of 1 mark.
2.	(a)		spiral wrap(ping)	1	
	(b)		<div>connect to both ends of cable 1</div> <div>lamp/LED lights 1</div>	2	
	(c)		<div>colour coding 1</div> <div>numbering 1</div>	2	

3. A student sets up a circuit as shown.



(a) Switch  $S$  is open.

(i) Calculate the total resistance of the circuit.

1

(ii) Calculate the current in the circuit.

3

(b) Switch  $S$  is now closed.

(i) Calculate the effective resistance of the two resistors in parallel.

3

(ii) Calculate the overall circuit resistance.

1



\* S 8 6 0 7 5 0 1 0 6 \*

4. Logic gates are widely used in electronic circuits.

(a) The truth table for a logic gate is shown.

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

Name the gate that produces this truth table.

1

(b) A logic gate is shown below.



Determine the logic state at X that would produce the output shown.

1

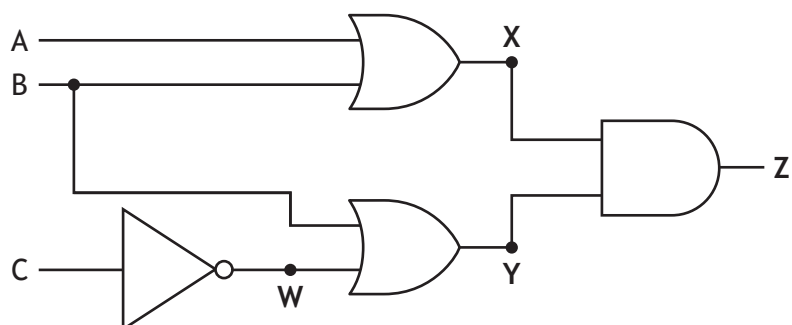
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\* S 8 6 0 7 5 0 1 0 7 \*

4. (continued)

(c)



Complete the truth table for the circuit.

4

A	B	C	W	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				

(An additional truth table, if required, can be found on *page 18*.)



Question			Answer	Max mark	Additional guidance																																				
3.	(a)	(i)	6 Ω	1	Unit required.																																				
		(ii)	<div><div><math>V = IR</math></div><div>1</div></div> <div><div><math>12 = I \times 6</math></div><div>1</div></div> <div><div><math>I = 2 \text{ A}</math></div><div>1</div></div>	3	Or consistent with (a)(i)																																				
	(b)	(i)	<div><div><math>\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}</math></div><div>1</div></div> <div><div><math>\frac{1}{R} = \frac{1}{4} + \frac{1}{12}</math></div><div>1</div></div> <div><div><math>R_T = 3 \text{ Ω}</math></div><div>1</div></div>	3	<div><math>R_T = \frac{R_1 R_2}{R_1 + R_2}</math></div> <div>is an acceptable alternative method.</div> <div>If wrong equation used, eg</div> <div><math>R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}</math></div> <div>then (0) marks</div> <div>Accept imprecise working towards a final answer.</div> <div><math>\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{12} = 3 \text{ Ω}</math></div> <div><div>↑</div><div>accept</div></div>																																				
		(ii)	5 Ω	1	Unit required. Or consistent with (b)(i)																																				
4.	(a)		XOR or exclusive OR	1																																					
	(b)		1	1																																					
	(c)		<table><tr><td>W</td><td>X</td><td>Y</td><td>Z</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr></table> <div>1 mark for each correct column. Apply follow through between columns.</div>	W	X	Y	Z	1	0	1	0	0	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	0	1	1	1	4	
W	X	Y	Z																																						
1	0	1	0																																						
0	0	0	0																																						
1	1	1	1																																						
0	1	1	1																																						
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0	1	0	0																																						
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0	1	1	1																																						

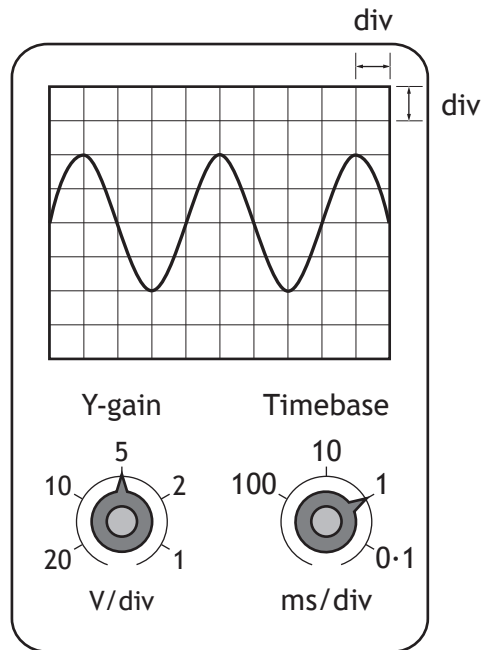
MARKS

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5. (a) The output from a signal generator is connected to the input terminals of an oscilloscope.

The trace is shown on the screen.

The Y-gain and timebase settings are also shown.



Determine the peak voltage of the signal.

1

[Turn over



\* S 8 6 0 7 5 0 1 0 9 \*

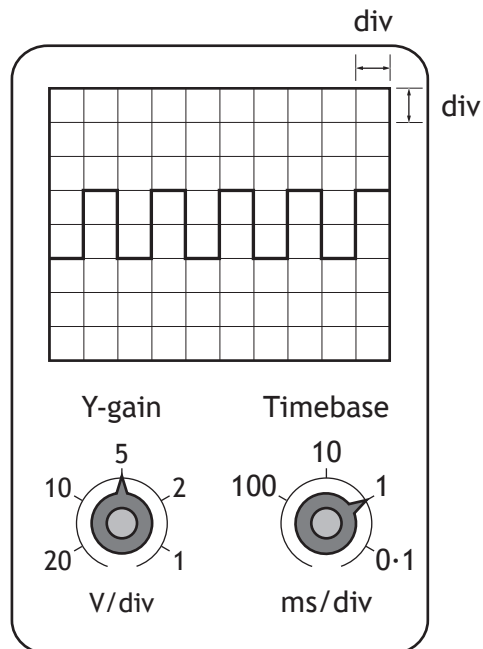
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## 5. (continued)

- (b) The output from the signal generator was changed to produce the trace shown below.

The Y-gain and timebase settings are also shown.



- (i) State whether the signal is analogue or digital.

1

- (ii) Determine the frequency of the signal.

3



\* S 8 6 0 7 5 0 1 1 0 \*

MARKS

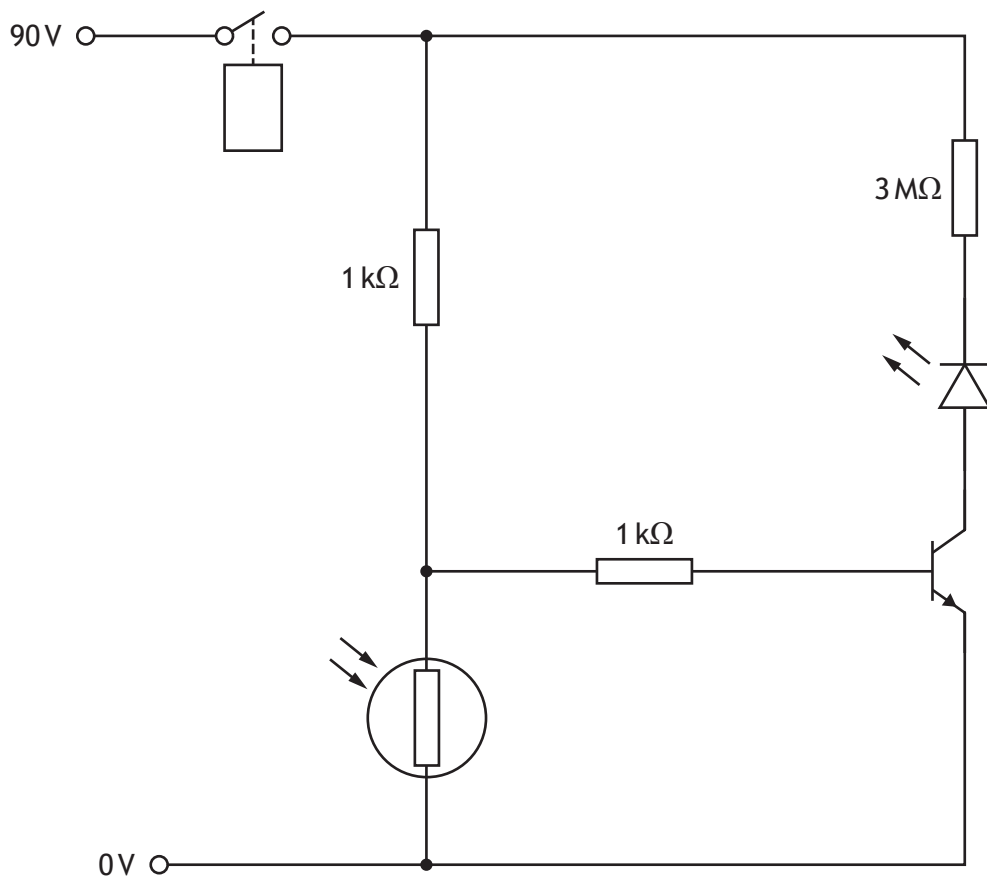
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6. Simulation is used extensively in circuit design.

(a) Give two reasons for simulating a circuit before it is constructed.

2

(b) A student simulated the circuit shown.



Identify the **three** errors in the circuit.

3

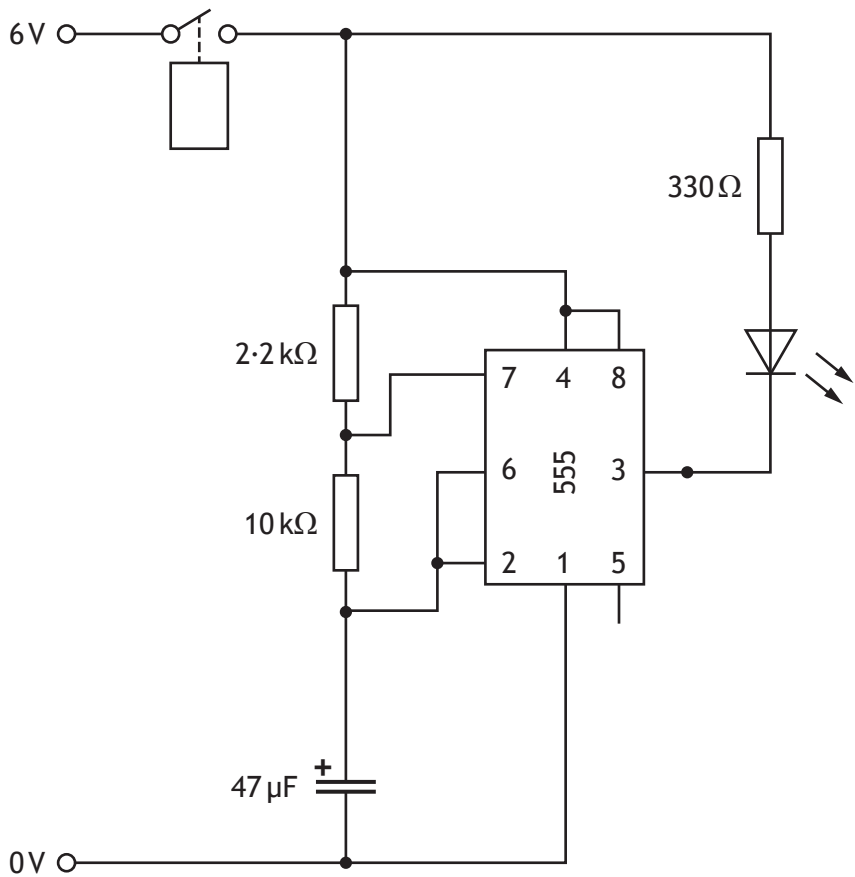
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\* S 8 6 0 7 5 0 1 1 1 \*

6. (continued)

(c) The student also simulated the 555 timer circuit shown below.



Complete the following table by giving **three** pre-power up checks for this circuit.

3

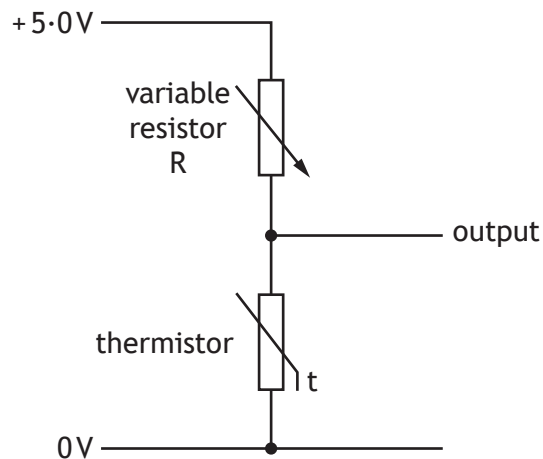
Pre-power up checklist
Check IC orientation

Question			Answer	Max mark	Additional guidance
5.	(a)		10 V	1	
	(b)	(i)	digital	1	
		(ii)	$T = (2 \times 1 \text{ ms}) = 2 \text{ ms}$ 1 $f = \frac{1}{T}$ 1 $f = 500 \text{ Hz}$ 1	3	<p>If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula.</p> <p>If period incorrect then award a maximum of 1 mark for the formula.</p> <p>If milli omitted from the period of the wave, treat as a unit error and award a maximum of 2 marks, unless final answer is then quoted as 0.5 kHz, in which case 3 marks may be awarded.</p>
6.	(a)		<p>to establish if the circuit works to improve the circuit design easily edited to try different combinations allows testing of sub-systems</p> <p>Any other suitable response. Any two for 1 mark each.</p>	2	Not: allows you to cost the circuit.
	(b)		<p>incorrect/too large supply voltage 1</p> <p>protective resistance for LED is too large 1</p> <p>LED connected wrong way round 1</p>	3	
	(c)		<p>orientation of capacitor</p> <p>orientation of LED</p> <p>supply voltage</p> <p>resistance values</p> <p>Any three for 1 mark each.</p>	3	

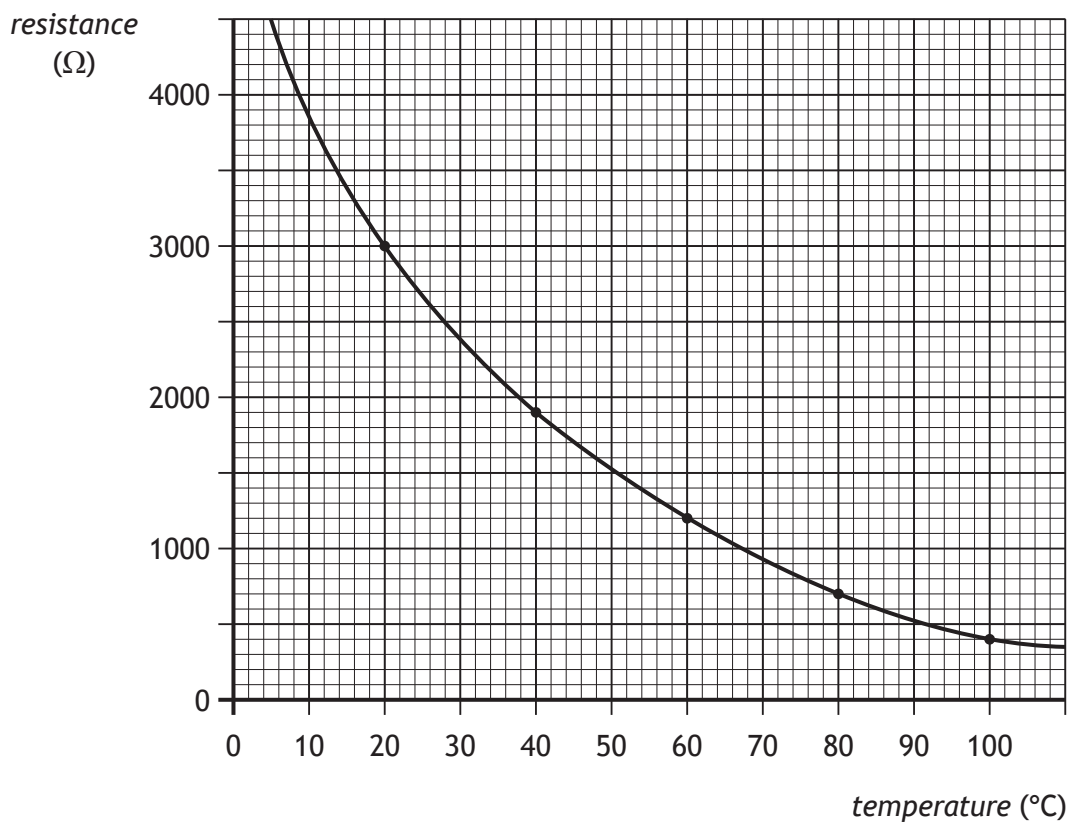
MARKS

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7. A thermistor is used as a temperature sensor in a circuit to monitor and control the temperature of water in a tank. Part of the circuit is shown.



- (a) (i) The graph shows how the resistance of the thermistor varies with temperature.



Use the graph to determine the resistance of the thermistor when the temperature is 60 °C.

1

[Turn over



\* S 8 6 0 7 5 0 1 1 3 \*

MARKS

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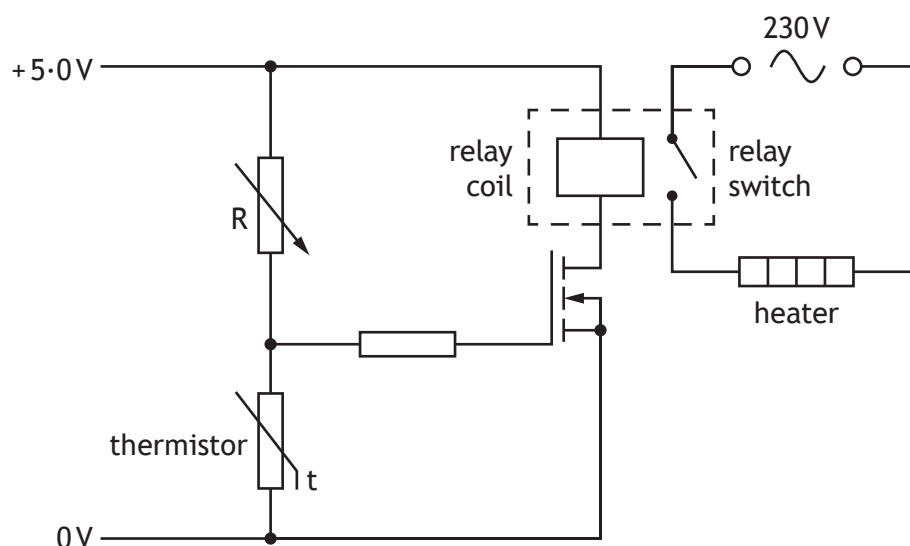
## 7. (a) (continued)

- (ii) The variable resistor  $R$  is now set at a resistance of  $800\ \Omega$ .

Calculate the voltage across the thermistor when the temperature is  $60\ ^\circ\text{C}$ .

3

- (b) The potential divider is now connected to a switching circuit to operate a heater.



- (i) Explain how the circuit operates to switch on the heater when the temperature falls below a certain value.

3

- (ii) The operation of this circuit can be improved by the addition of one component connected across the relay.

Name this component.

1



\* S 8 6 0 7 5 0 1 1 4 \*

MARKS

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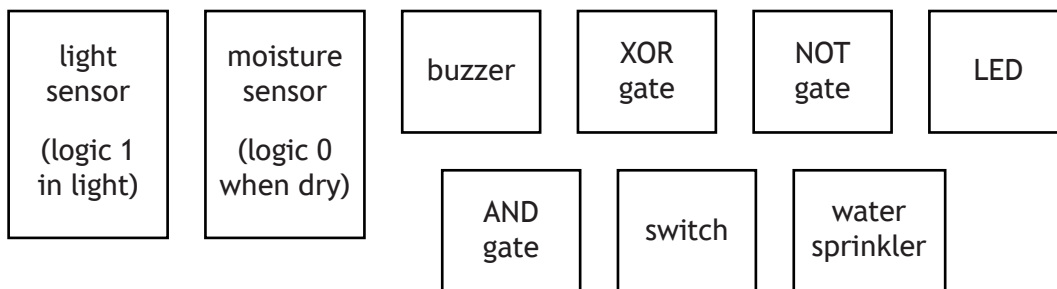
8. An engineer designs a system to control the moisture of the soil in a greenhouse.

The system must include a sensor which will measure the moisture content of the soil and turn on a water sprinkler system if the soil is too dry. An LED indicator should be included to show when the system is operating. There should also be a manual shut down switch to turn the system off when it is not required.

Selecting from the elements given below, draw a block diagram of an electronic solution that meets the engineer's criteria.

On your diagram, clearly indicate the input, process and output sections of your solution.

6



[Turn over



Question			Answer	Max mark	Additional guidance
7.	(a)	(i)	1200 $\Omega$ or 1k2	1	
		(ii)	$V_1 = \frac{R_1}{R_1 + R_2} \times V_s$ 1 $V_1 = \frac{1200}{1200 + 800} \times 5.0$ 1 $V_1 = 3 \text{ V}$ 1	3	<p>Or consistent with (a)(i)</p> <p>Using Ohm's law:  <math>R_T (= 1200 + 800) = 2000</math>  <math>I = \frac{V}{R}</math>  <math>I = \frac{5.0}{2000}</math>  <math>I = 2.5 \times 10^{-3} \text{ A}</math>  <math>V_1 = IR</math>  <math>V_1 = 2.5 \times 10^{-3} \times 1200</math>  <math>V_1 = 3 \text{ V}</math></p> <p>1 mark for Ohm's Law relationship  1 mark for all substitutions  1 mark for final answer including unit</p>
	(b)	(i)	Resistance of thermistor increases so voltage across it increases. 1 Transistor switches on at a certain voltage/2 V. 1 Relay activates and closes contacts in heater circuit. 1	3	If transistor switching voltage is given as 0.7 V award a maximum of 2 marks.
		(ii)	diode	1	
8.			1 mark for selecting both input devices 1 mark for selecting correct gates 1 mark for selecting both output devices 1 mark for correctly linking the inputs and gates 1 mark for correctly linking the outputs to the gates (arrows are NOT required on the connections) 1 mark for correctly identifying the three sections of the system	6	

MARKS

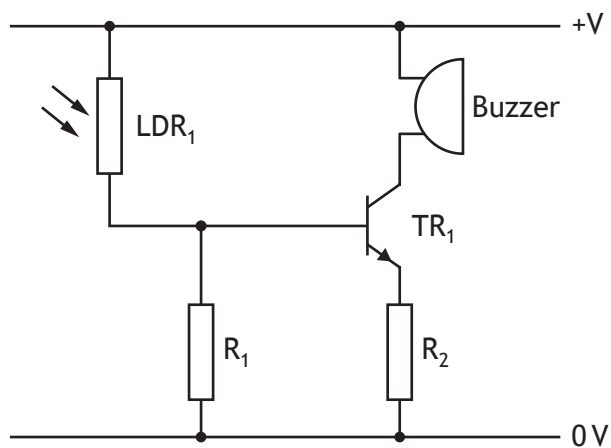
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9. (a) State two precautions that should be taken when soldering.

2

- (b) For the circuit diagram shown, complete the layout diagram.

5



#### Component data

$R_1$  – carbon film  $10\text{ k}\Omega$   $0.25\text{ W}$

$R_2$  – carbon film  $1\text{ k}\Omega$   $0.25\text{ W}$

$\text{LDR}_1$  – ORP12

$\text{TR}_1$  – BC108 npn bipolar

Buzzer – 6 V dc



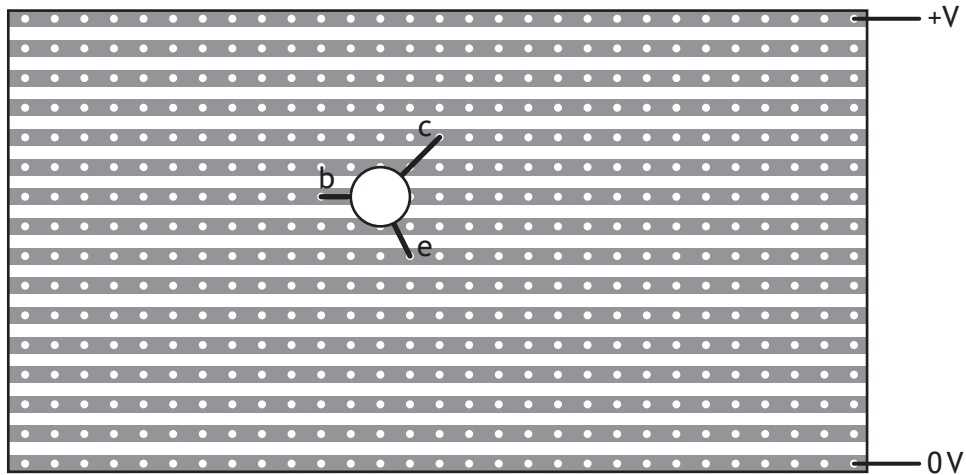
\* S 8 6 0 7 5 0 1 1 6 \*

MARKS

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9. (b) (continued)

Layout diagram



(Additional layout diagrams, if required, can be found on *page 19*.)

[END OF SPECIMEN QUESTION PAPER]




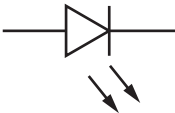
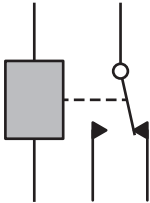
Question			Answer	Max mark	Additional guidance
9.	(a)		wear eye protection suitable ventilation avoid breathing in fumes  Any other sensible suggestion. Any two for 1 mark each.	2	
	(b)		1 mark for each of the correctly positioned components.  1 mark for labelling all of the components.	5	‘footprint’ of components should be of an appropriate size

[END OF SPECIMEN MARKING INSTRUCTIONS]

Total marks — 60  
Attempt ALL questions

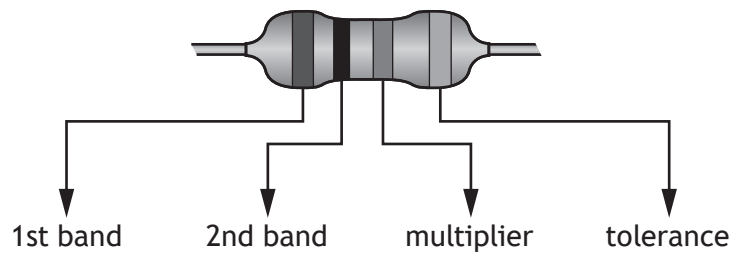
1. (a) The table gives information about some circuit components.  
Some of the boxes have been left blank.  
Complete the table for the missing entries.

3

Name	Symbol	Function
electrolytic capacitor		stores charge
		emits light
relay		
741 operational amplifier (op-amp)		comparator

## 1. (continued)

(b) The following diagram shows the colour coding for a resistor.



A student is comparing two resistors  $R_1$  and  $R_2$ . The colour code for each resistor is given in the table below.

<i>Resistor</i>	<i>1st band</i>	<i>2nd band</i>	<i>Multiplier</i>	<i>Tolerance</i>
$R_1$	brown	red	orange	silver
$R_2$	brown	red	orange	brown

Using information from the data sheet:

- (i) determine the resistance of resistor  $R_1$ ; 1
- (ii) state the percentage tolerance value of resistor  $R_2$ ; 1
- (iii) determine the colour codes for a resistor of value  $6K8 \pm 5\%$ . 2

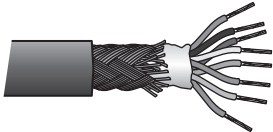
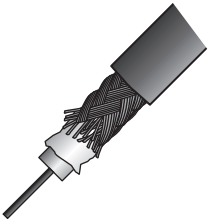
<i>1st band</i>	<i>2nd band</i>	<i>Multiplier</i>	<i>Tolerance</i>
			gold

[Turn over



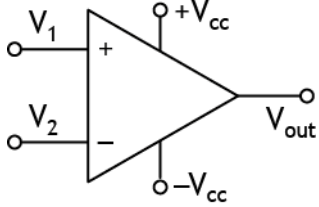
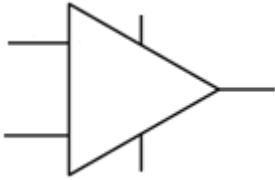
2. Complete the table by stating a typical use for each cable type shown.

2

	Cable type	Typical use
	multi-strand	
	coaxial	

[Turn over

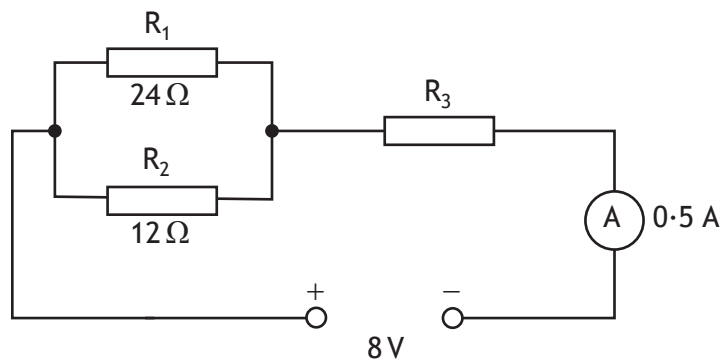
## Marking instructions for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Light emitting diode/LED (1 mark) Electromagnetic switch (1 mark)  (1 mark)	3	Relay- explains control of high power/current/voltage circuit via a low power/current/voltage circuit. Minimum acceptable 741 diagram 
	(b)	(i)	12 000 $\Omega$ / 12 k $\Omega$ / 12K	1	
		(ii)	( $\pm$ ) 1 (%)	1	
		(iii)	Blue and grey (1 mark) Red (1 mark)	2	1 mark for first and second bands correct. 1 mark for multiplier.
2.			Multi-strand: phone/telecom (1 mark) Coaxial: aerial/TV signal/radio signals/connecting CRO/audio (1 mark)	2	Accept any sensible suggestions.

MARKS

DO NOT  
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3. A student sets up the circuit shown.



- (a) Calculate the total resistance of the circuit.

3

*Space for working and answer*

- (b) Calculate the effective resistance of  $R_1$  and  $R_2$  in parallel.

3

*Space for working and answer*

- (c) Determine the resistance of resistor  $R_3$ .

1

*Space for working and answer*



\* X 8 6 0 7 5 0 1 0 6 \*

MARKS  
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MARGIN

3. (continued)

(d) Determine the voltage across  $R_3$ .  
*Space for working and answer*

1

(e) Calculate the power dissipated in resistor  $R_3$ .  
*Space for working and answer*

3

[Turn over



Question			Expected response	Max mark	Additional guidance
3.	(a)		$V = IR$ (1 mark) $8 = 0.5 \times R$ (1 mark) $R = 16 \Omega$ (1 mark)	3	Accept 16R
	(b)		$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1 mark) $\frac{1}{R_T} = \frac{1}{24} + \frac{1}{12}$ (1 mark) $R_T = 8 \Omega$ (1 mark)	3	$R_T = \frac{R_1 R_2}{R_1 + R_2}$ is an acceptable alternative method. If wrong equation used, eg $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$ then (0) marks. Accept imprecise working towards a final answer. $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{12} + \frac{1}{24} = 8 \Omega$ <div style="text-align: center;"> <math>\uparrow</math>              accept           </div> Accept 8R
	(c)		$R_3 = 8 \Omega$	1	Or consistent with (a) and (b). Accept 8R
	(d)		$V_3 = 4 \text{ V}$	1	Or consistent with (a), (b), and (c).
	(e)		$P = \frac{V^2}{R}$ (1 mark) $P = \frac{4^2}{8}$ (1 mark) $P = 2 \text{ W}$ (1 mark)	3	Or consistent with (a), (b), (c), and (d). $P = IV$ 1 $P = 0.5 \times 4$ 1 $P = 2 \text{ W}$ 1 Or $P = I^2 R$ 1 $P = 0.5^2 \times 8$ 1 $P = 2 \text{ W}$ 1

4. Logic gates are widely used in electronic circuits.

(a) Complete the truth table for an OR gate.

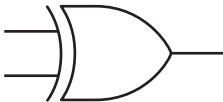
1

A	B	Output
0	0	
0	1	
1	0	
1	1	

(An additional truth table, if required, can be found on *page 24*.)

(b) Name the logic gate shown below.

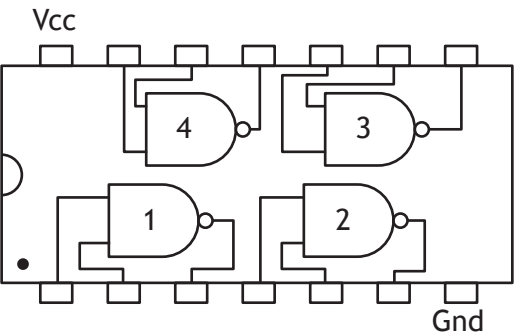
1



4. (continued)

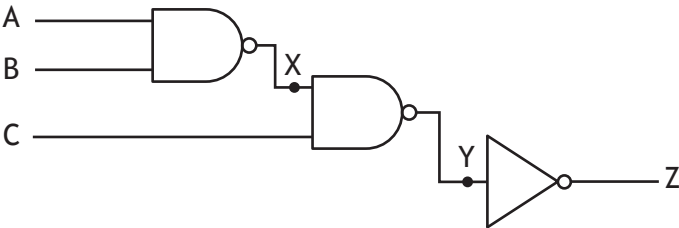
- (c) Using information from the data sheet, identify the **integrated circuit (IC)** shown.

1



- (d) Complete the truth table for the logic circuit shown.

3



A	B	C	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			

(An additional truth table, if required, can be found on *page 24.*)

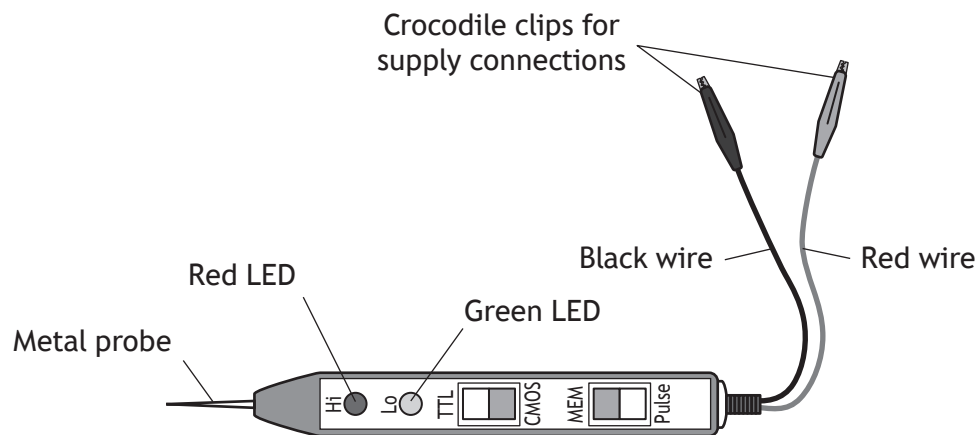


Question			Expected response			Max mark	Additional guidance																																																						
4.	(a)		<table><tr><td>A</td><td>B</td><td>Output</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>			A	B	Output	0	0	0	0	1	1	1	0	1	1	1	1	1																																								
			A	B	Output																																																								
			0	0	0																																																								
			0	1	1																																																								
			1	0	1																																																								
1	1	1																																																											
	(b)		Exclusive OR / XOR			1																																																							
	(c)		7400 (quad 2 input NAND gates)  OR  Quad 2 input NAND (gates)			1	Do not accept NAND on its own.																																																						
	(d)		<table><tr><td>A</td><td>B</td><td>C</td><td>X</td><td>Y</td><td>Z</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr></table>			A	B	C	X	Y	Z	0	0	0	1	1	0	0	0	1	1	0	1	0	1	0	1	1	0	0	1	1	1	0	1	1	0	0	1	1	0	1	0	1	1	0	1	1	1	0	0	1	0	1	1	1	0	1	0	3	1 mark for each column.  Apply follow through between columns.
A	B	C	X	Y	Z																																																								
0	0	0	1	1	0																																																								
0	0	1	1	0	1																																																								
0	1	0	1	1	0																																																								
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1	0	1	1	0	1																																																								
1	1	0	0	1	0																																																								
1	1	1	0	1	0																																																								
5.			Connect red wire of probe to V <sub>supply</sub> and black wire to 0 V or equivalent. (1 mark)			3	Do not accept: connect the probe to the supply rails (on its own).  3 independent marks																																																						
			Place the probe tip onto circuit at selected point. (1 mark)																																																										
			Red LED lights. (1 mark)																																																										

MARKS

DO NOT  
WRITE IN  
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MARGIN

5. A logic probe is used to test the inputs and outputs of a 74 series logic chip. The logic probe is set to TTL and pulse.



Describe how to connect and use the logic probe to test the inputs and outputs of the chip.

In your answer include how a logic 1 is detected.

3

[Turn over



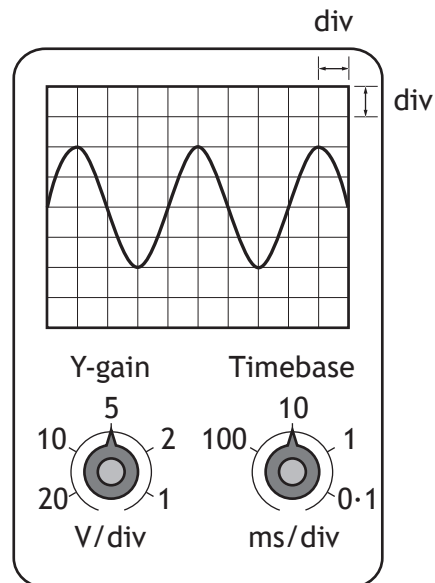
MARKS

DO NOT  
WRITE IN  
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MARGIN

6. (a) The output from a signal generator is connected to the input terminals of an oscilloscope.

The trace is shown on the screen.

The Y-gain and timebase settings are also shown.



Determine the frequency of the signal.

3

*Space for working and answer*



\* X 8 6 0 7 5 0 1 1 2 \*

MARKS

DO NOT  
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## 6. (continued)

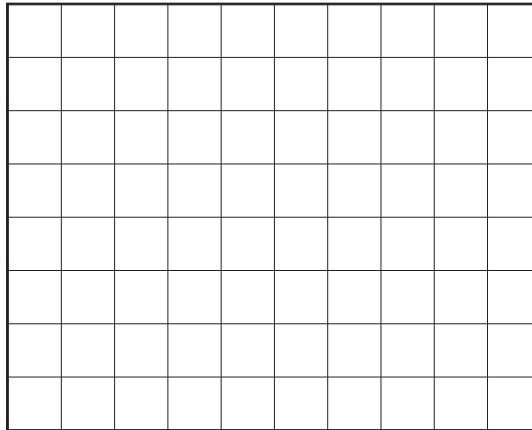
- (b) The peak voltage of the output signal from the signal generator is now **doubled**.

The frequency of the signal is unchanged.

The settings on the oscilloscope are unchanged.

Draw the new trace that would be shown on the screen.

1

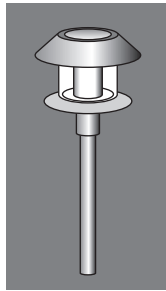


(An additional diagram, if required, can be found on *page 24*.)

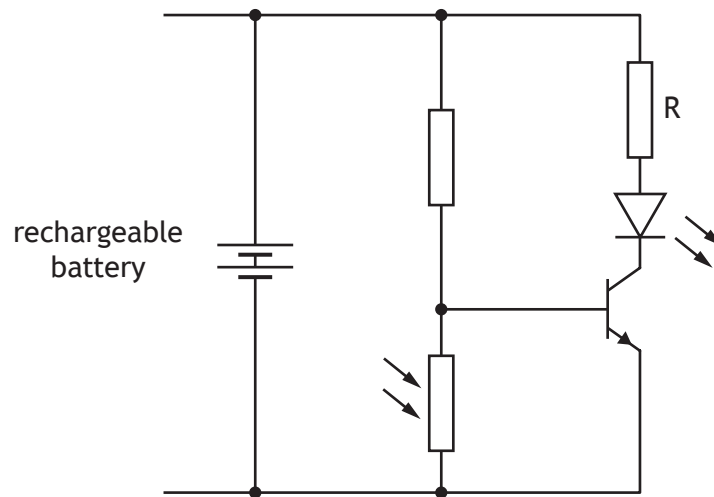
[Turn over



7. A high intensity LED is used as a garden light. The light turns on automatically when it becomes dark.



(a) The LED is switched on using the following circuit.

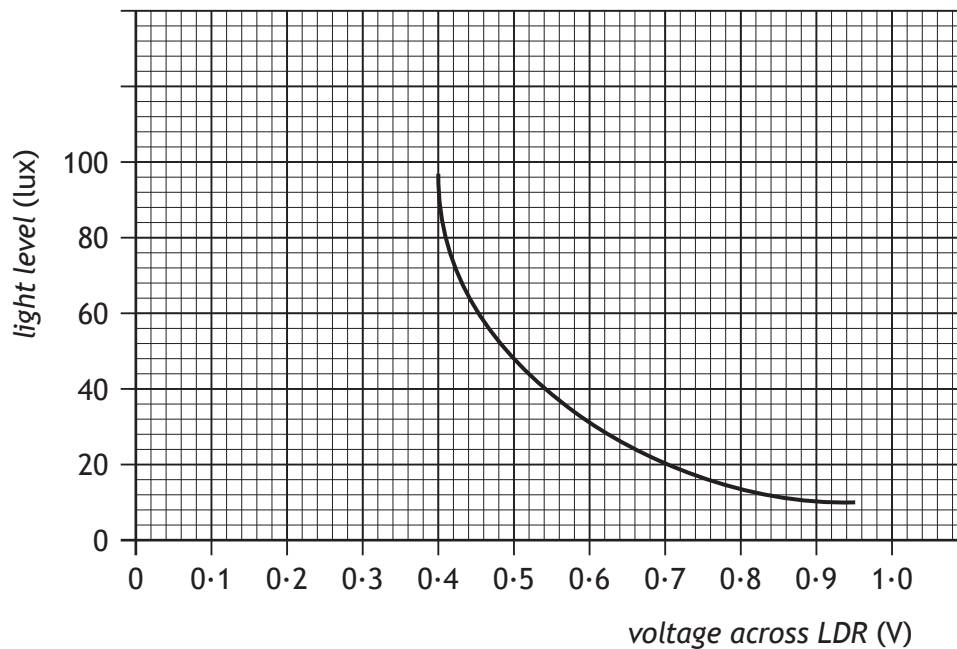


MARKS

DO NOT  
WRITE IN  
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MARGIN

## 7. (a) (continued)

The graph shows the voltage across the LDR in this circuit for different light levels.



- (i) For the LED to switch on, the voltage across the LDR must be at least 0.7 V.

Determine the light level at which the LED switches on.

1

- (ii) Explain the purpose of resistor R.

1

- (iii) The manufacturer has used a bipolar transistor, as a MOSFET cannot be used in this circuit.

Explain why a MOSFET cannot be used in this circuit.

1

[Turn over

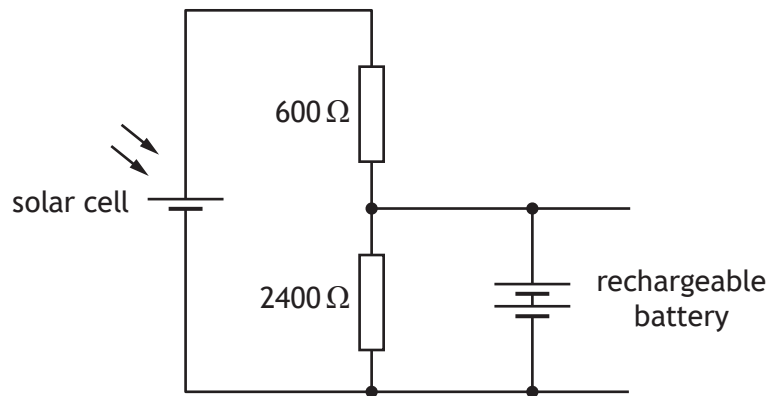


\* X 8 6 0 7 5 0 1 1 5 \*

## 7. (continued)

- (b) The light also contains a solar cell which charges the rechargeable battery during daylight hours.

Part of the circuit is shown.



At a particular light level, the voltage generated by the solar cell is  $1.5\text{ V}$ .

Calculate the voltage across the rechargeable battery at this light level.

3

*Space for working and answer*



Question			Expected response	Max mark	Additional guidance
6.	(a)		$T = (4 \times 10 \text{ ms}) = 40 \text{ ms}$ (1 mark) $f = \frac{1}{T}$ (1 mark) $f = 25 \text{ Hz}$ (1 mark)	3	<p>If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula.</p> <p>If period incorrect then award a maximum of 1 mark for the formula.</p> <p>If milli omitted from the period of the wave, treat as a unit error and award a maximum of 2 marks, unless final answer is then quoted as 0.025 kHz, in which case 3 marks may be awarded.</p>
	(b)		Trace should have double the amplitude (with 3 peaks and two troughs).	1	
7.	(a)	(i)	20 lux	1	
		(ii)	Drop voltage/reduce current/protect LED/limit power.	1	Do not accept: voltage 'through' or current 'across' on their own.
		(iii)	Switch on voltage too high/2 V.	1	
	(b)		$V_2 = \frac{R_2}{R_1 + R_2} \times V_s$ (1 mark) $V_2 = \frac{2400}{600 + 2400} \times 1.5$ (1 mark) $V_2 = 1.2 \text{ V}$ (1 mark)	3	$V = IR$ $1.5 = I \times 3000$ $I = 5 \times 10^{-4} \text{ (A)}$ $V = IR$ $V = 5 \times 10^{-4} \times 2400$ $V = 1.2 \text{ V}$ <p>1 mark for Ohm's Law anywhere.            1 mark for <b>both</b> substitutions.            1 mark for final answer including unit.</p> <p>Or by voltage ratio method.</p> <p>If correct answer given with no working award 3 marks.</p>

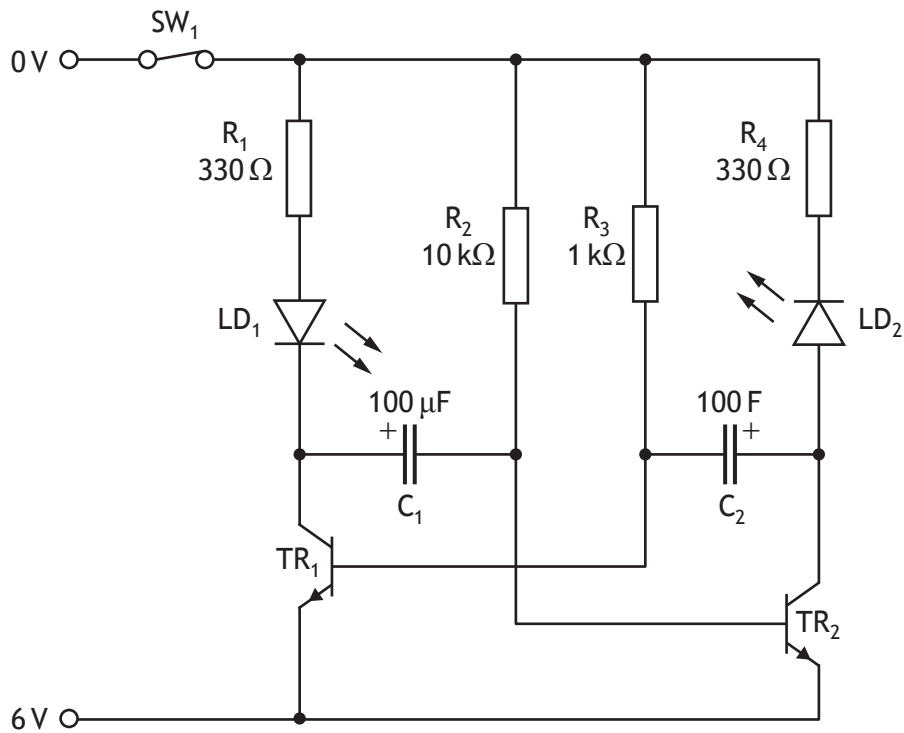
MARKS

DO NOT  
WRITE IN  
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MARGIN

8. When switched on, the circuit shown should have the LEDs alternately flashing at the same rate. However the student has made four errors.

Identify the four errors.

4



Error 1:

Error 2:

Error 3:

Error 4:

[Turn over

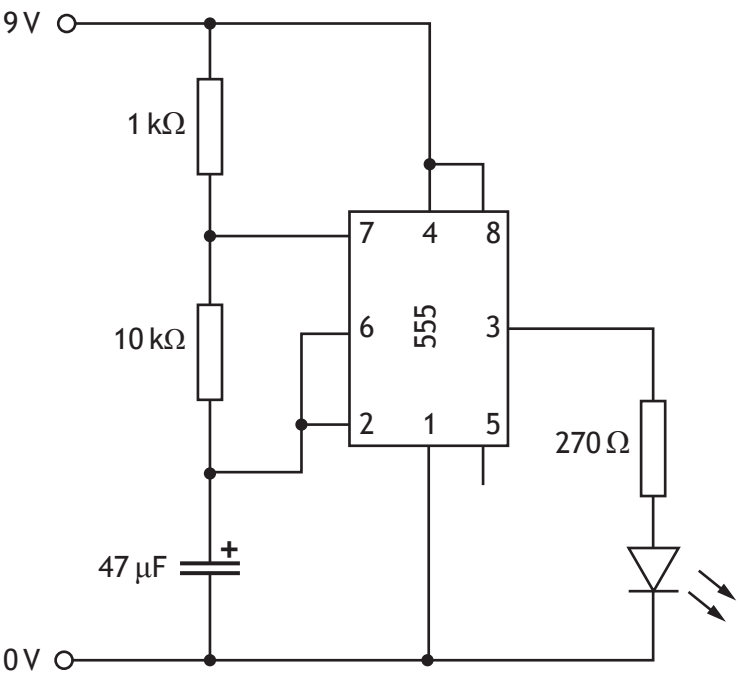


\* X 8 6 0 7 5 0 1 1 7 \*

MARKS

DO NOT WRITE IN THIS MARGIN

9. A student builds the circuit shown.



Using the information from two suppliers' catalogues shown on the opposite page, complete the costings sheet to produce the **lowest** cost for the circuit. 5

Supplier	Component	Product code	Cost (p)
JIMSON	NE555	TC124	20
SWIFT	8 way DIL socket	SK-0080	10
	LED 5 mm std		
	47 µF electrolytic capacitor		
	270R		
	1K		
	10K		

## 9. (continued)

Supplier	SWIFT			
	Component	Description	Product code	Cost
Integrated circuits	LM555CM	timers	IC-0283	45p
	NE555	timers	IC-0254	32p
	NE556	timers	IC-0216	25p
	8 way dil	ic socket	SK-0080	10p
Semi-conductors	LED	5 mm std red	SC-0155	4p
	LED	10 mm std red	SC-0177	10p
Electrolytic capacitors	10 $\mu$ F	16 V	CP-0555	10p
	47 $\mu$ F	16 V	CP-0566	18p
	47 $\mu$ F	6 V	CP-0588	10p
	47 $\mu$ F	5 V	CP-0599	8p
Resistors	220R	0.25 W carbon film 5%	EC-0159	0.5p
	270R	0.25 W carbon film 5%	EC-0161	0.5p
	1K	0.25 W carbon film 5%	EC-0175	0.5p
	10K	0.25 W carbon film 5%	EC-0182	1.5p
	100K	0.25 W carbon film 5%	EC-0198	3p
Supplier	JIMSON			
	Component	Description	Product code	Cost
Integrated circuits	LM555CM	timers	TC 123	90p
	NE555	timers	TC 124	20p
	NE556	timers	TC 125	80p
	8 way dil	ic socket	SK 099	50p
Semi-conductors	LED	5 mm std red	LD345	12p
	LED	10 mm std red	LD346	20p
Electrolytic capacitors	10 $\mu$ F	16 V	EC 798	10p
	47 $\mu$ F	16 V	EC 799	14p
	47 $\mu$ F	6 V	EC 800	10p
	47 $\mu$ F	5 V	EC 801	8p
Resistors	220R	0.25 W carbon film 5%	FR 921	0.25p
	270R	0.25 W carbon film 5%	FR 922	0.25p
	1K	0.25 W carbon film 5%	FR 923	0.25p
	10K	0.25 W carbon film 5%	FR 924	2p
	100K	0.25 W carbon film 5%	FR 925	5p



\* X 8 6 0 7 5 0 1 1 9 \*

Question			Expected response	Max mark	Additional guidance																																
8.			<p>Power supply reversed/ wrong way round. (1 mark)</p> <p>LD<sub>2</sub> wrong polarity/wrong way round. (1 mark)</p> <p>C<sub>2</sub> value incorrect/too big/ different. (1 mark)</p> <p>R<sub>2</sub> / R<sub>3</sub> value incorrect/ different. (1 mark)</p>	4	<p>Errors can be listed in any order.</p> <p>Battery not accepted</p>																																
9.			<table><tr><td>Supplier</td><td>Component</td><td>Product code</td><td>Cost (p)</td></tr><tr><td>JIMSON</td><td>NE555</td><td>TC124</td><td>20</td></tr><tr><td>SWIFT</td><td>8 way DIL socket</td><td>SK-0080</td><td>10</td></tr><tr><td>SWIFT</td><td>LED 5mm std</td><td>SC-0155</td><td>4</td></tr><tr><td>JIMSON</td><td>47µF electrolytic capacitor</td><td>EC799</td><td>14</td></tr><tr><td>JIMSON</td><td>270R</td><td>FR922</td><td>0.25</td></tr><tr><td>JIMSON</td><td>1K</td><td>FR923</td><td>0.25</td></tr><tr><td>SWIFT</td><td>10K</td><td>EC-0182</td><td>1.5</td></tr></table>	Supplier	Component	Product code	Cost (p)	JIMSON	NE555	TC124	20	SWIFT	8 way DIL socket	SK-0080	10	SWIFT	LED 5mm std	SC-0155	4	JIMSON	47µF electrolytic capacitor	EC799	14	JIMSON	270R	FR922	0.25	JIMSON	1K	FR923	0.25	SWIFT	10K	EC-0182	1.5	5	<p>1 mark for each correct row.</p>
Supplier	Component	Product code	Cost (p)																																		
JIMSON	NE555	TC124	20																																		
SWIFT	8 way DIL socket	SK-0080	10																																		
SWIFT	LED 5mm std	SC-0155	4																																		
JIMSON	47µF electrolytic capacitor	EC799	14																																		
JIMSON	270R	FR922	0.25																																		
JIMSON	1K	FR923	0.25																																		
SWIFT	10K	EC-0182	1.5																																		

10. An engineer designs a system to control the temperature within a greenhouse.

The system includes a sensor which measures the temperature within the greenhouse.

If the temperature exceeds 24 °C this turns on a motor to open a window.

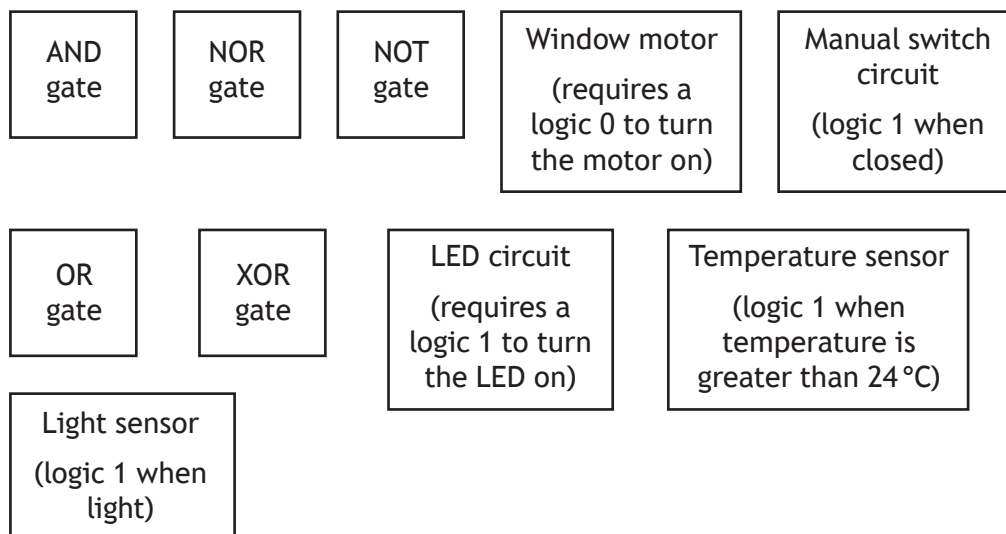
An LED indicator lights when the window is open.

There is also a manual switch to turn the whole system on and off.

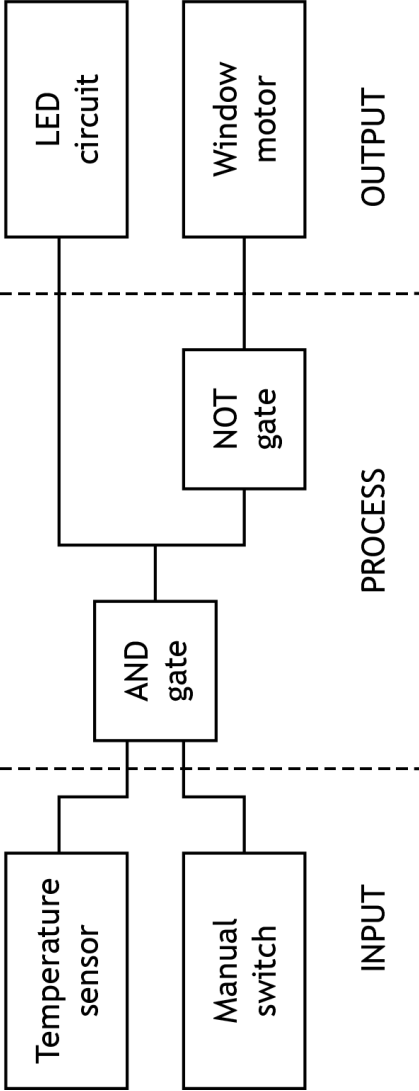
Selecting from the elements given, draw a block diagram of an electronic solution for this system.

On your diagram, clearly indicate the input, process and output sections of your solution.

6



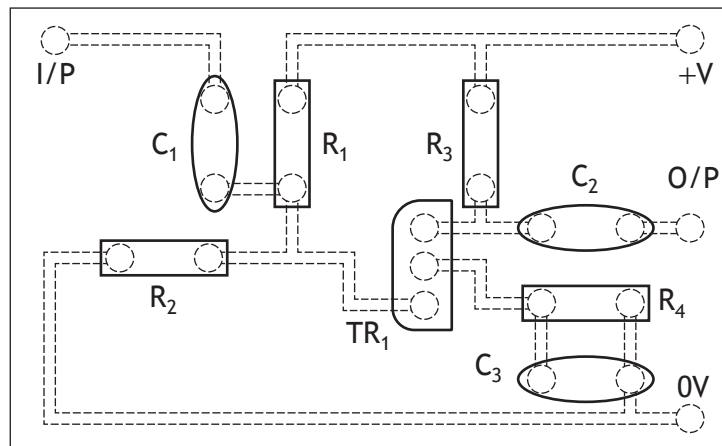
\* X 8 6 0 7 5 0 1 2 0 \*

Question	Expected response	Max mark	Additional guidance
10.	<p>1 mark for selecting both input devices.</p> <p>1 mark for selecting correct gates.</p> <p>1 mark for selecting both output devices.</p> <p>1 mark for correctly linking the inputs to gates.</p> <p>1 mark for correctly linking the outputs to the gates.</p> <p>1 mark for correctly identifying the three sections of the system diagram.</p>  <pre> graph TD     subgraph INPUT         TS[Temperature sensor]         MS[Manual switch]     end     subgraph PROCESS         AG[AND gate]         NG[NOT gate]     end     subgraph OUTPUT         LC[LED circuit]         WM[Window motor]     end     TS --- AG     MS --- AG     AG --- NG     NG --- WM     AG --- LC </pre>	6	<p>All selected elements must be shown as part of a system/block diagram.</p> <p>(arrows are NOT required on the connections).</p>

MARKS

DO NOT  
WRITE IN  
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11. The following PCB layout shows a circuit with the following component data.



### Component data

$R_1$  — carbon film 82K 0.25 W

$R_2$  — carbon film 10K 0.25 W

$R_3$  — carbon film 8K2 0.25 W

$R_4$  — carbon film 1K 0.25 W

$C_1$  — 0.1  $\mu$ F

$C_2$  — 0.1  $\mu$ F

$C_3$  — 10  $\mu$ F

$TR_1$  — BC182 npn bipolar



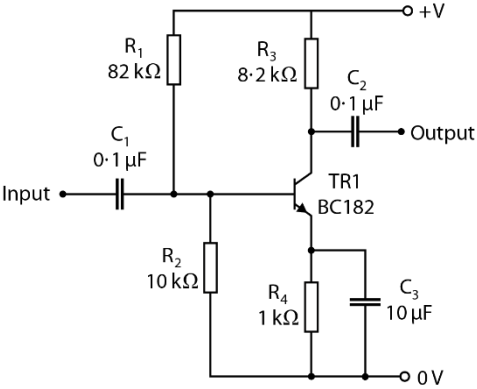

$TR_1$  pin connections

Draw a circuit diagram for this circuit.

Each component must be labelled.

6



Question		Expected response	Max mark	Additional guidance
11.		<p>1 mark for both power rails.</p> <p>1 mark for transistor oriented in a functional manner and uses correct symbol.</p> <p>1 mark for the four resistors (with correct symbol) relative to power rails and transistor.</p> <p>1 mark for C3 in parallel to R4 and uses acceptable symbol.</p> <p>1 mark for placement of input and C1(with correct symbol) relative to transistor.</p> <p>1 mark for placement of C2 (with correct symbol) and output relative to transistor.</p> 	6	<p>Component symbols must be used.</p> <p>Accept electrolytic capacitor symbols.</p> <p>Each component must be identifiable. Accept a mixture of component values and identifiers.</p> <p>(accept R notation)</p> <p>Node spot for input/outputs are not required.</p> <p>Power rails must have</p> <p>V+ or Vs and 0V with  end node.</p>

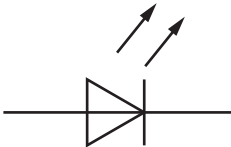
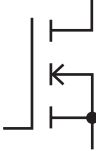

[END OF MARKING INSTRUCTIONS]

Total marks — 60

Attempt ALL questions

1. The table below gives information about some circuit components.  
Some of the boxes have been left blank.
- (a) Complete the table for the missing entries.

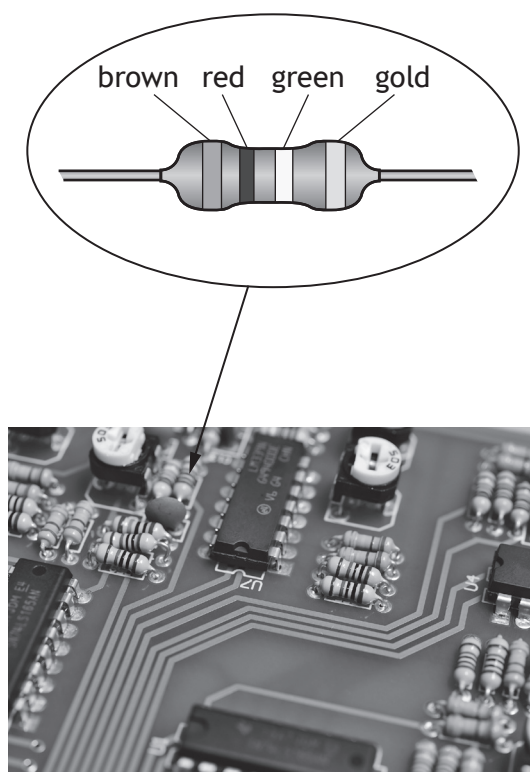
3

Component name	Symbol	Function
Light emitting diode		Emits light indicating a current flow
MOSFET transistor		
Motor		Converts electrical energy to kinetic energy
		To protect wiring from too much current

## 1. (continued)

- (b) A technician is examining the circuit board shown below when a fault is discovered.

A resistor with an incorrect value has been used.



Use the information in the data sheet to answer the questions below.

- (i) Determine the resistance of the resistor.

1

- (ii) The technician replaces the incorrect component with a resistor of value  $600\Omega$  which has a 2% tolerance.

Determine the minimum and maximum resistance of the resistor.

2

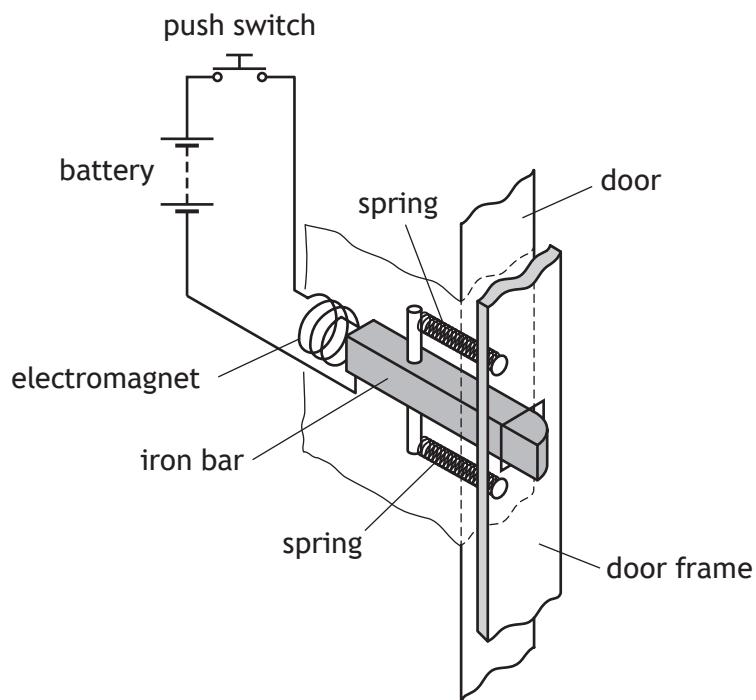


MARKS

DO NOT  
WRITE IN  
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MARGIN

2. A remote entry system for a block of flats allows a resident to unlock the outside door from inside their flat.

Part of this system is shown in the diagram below.



- (a) Explain how this part of the system operates to unlock the door.

2



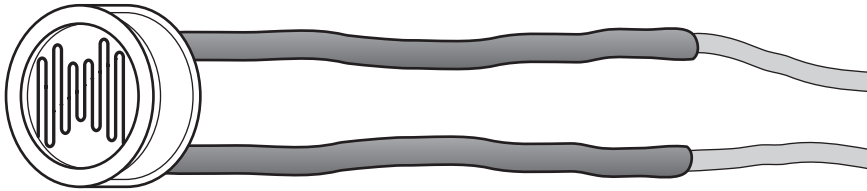
\* X 8 6 0 7 5 0 1 0 4 \*

MARKS

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## 2. (continued)

- (b) A light dependent resistor and sleeving is connected to a process board by two wires as shown in the picture below.



- (i) Name the wiring technique shown.

1

- (ii) State why this technique is used.


1

[Turn over



\* X 8 6 0 7 5 0 1 0 5 \*

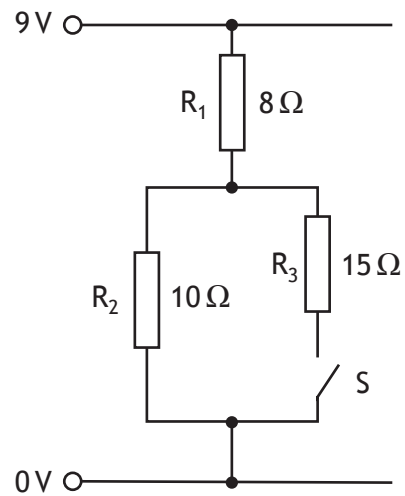
## Marking instruction for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Switch electrical (1 mark)   (1 mark)  FUSE (1 mark)	3	
	(b)	(i)	1M2 OR 1.2MΩ OR 1,200,000Ω	1	Also accept scientific notation with unit
		(ii)	Minimum 588Ω OR 588R (1 mark) Maximum 612Ω OR 612R (1 mark)	2	
2.	(a)		(When switch closed) current flows through electromagnet/coil (1 mark)  The iron bar is attracted by magnetism to the electromagnet/coil (1 mark)	2	
	(b)	(i)	Heat shrink (tubing)	1	Not sleeving Accept flying leads
		(ii)	To avoid short circuiting the LDR/ stop the bare wires touching	1	If flying leads then for remote connection to other parts of circuitry

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

3. A circuit diagram is shown below.



Switch  $S$  is **open**.

- (a) (i) Calculate the total resistance of the circuit.

1

*Space for working and answer*

- (ii) Calculate the current in the circuit.

3

*Space for working and answer*



\* X 8 6 0 7 5 0 1 0 6 \*

MARKS

DO NOT  
WRITE IN  
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## 3. (a) (continued)

(iii) Calculate the power dissipated in resistor  $R_1$ .

3

*Space for working and answer*(b) Switch S is now **closed**.Calculate the effective resistance of  $R_2$  and  $R_3$  in parallel.

3

*Space for working and answer*

[Turn over]



\* X 8 6 0 7 5 0 1 0 7 \*

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	$18\Omega$	1	Accept 18R
		(ii)	$V = IR$ (1 mark) $9 = I \times 18$ (1 mark) $I = 0.5 \text{ A}$ (1 mark)	3	Accept answer consistent with 3(a)(i)  Answer must have unit
		(iii)	$P = I^2 R$ (1 mark) $P = 0.5^2 \times 8$ (1 mark) $P = 2 \text{ W}$ (1 mark)	3	Accept answer consistent with 3(a)(ii)  Answer must have unit  Accept $P=IV = v^2/R$ if full working given
	(b)		$\frac{1}{R_T} = \frac{1}{R_2} + \frac{1}{R_3}$ (1 mark) $\frac{1}{R_T} = \frac{1}{10} + \frac{1}{15}$ (1 mark) $R_T = 6\Omega$ (1 mark)	3	$R_T = \frac{R_2 R_3}{R_2 + R_3}$ Is an acceptable alternative method  If wrong equation used, eg $R_T = \frac{1}{R_2} + \frac{1}{R_3}$ then (0) marks.  Accept imprecise working towards a final answer.  $\frac{1}{R_T} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{15} + \frac{1}{10} = 6\Omega$ <div style="text-align: center;"> <math>\uparrow</math>              accept           </div> Accept = 6 R  Accept any subscript on component resistors

4. There are many different types of logic gates used in electronic circuits.

(a) Draw the circuit symbol for a NAND gate.

1

(b) The truth table for a logic gate is shown below.

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

Name the logic gate that produces this truth table.

1

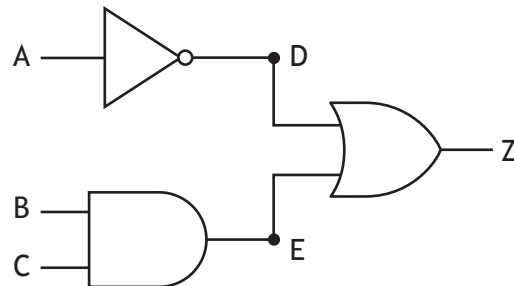


## 4. (continued)

Many electronic devices use several logic gates connected to one another.

(c) Complete the truth table for the logic circuit shown below.

3




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			

(An additional truth table, if required, can be found on *page 20*)

[Turn over



\* X 8 6 0 7 5 0 1 0 9 \*

Question			Expected response	Max mark	Additional guidance																																																						
4.	(a)			1																																																							
	(b)		NOR (gate)	1																																																							
	(c)		<table border="1"> <thead> <tr> <th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>Z</th></tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr> </tbody> </table>	A	B	C	D	E	Z	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	0	1	1	1	0	1	1	3	<p>1 mark per column</p> <p>Apply follow through between columns</p>
A	B	C	D	E	Z																																																						
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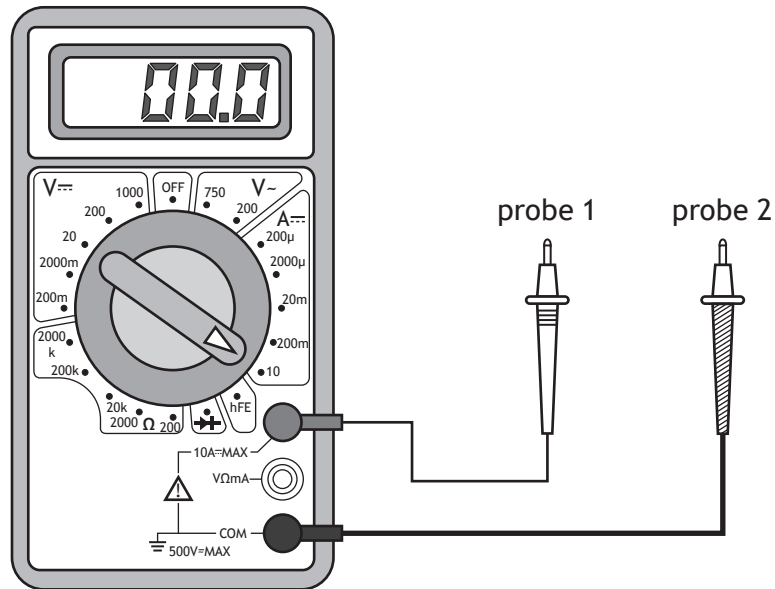
MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

5. A student wants to measure the **voltage** across a component in a circuit and sets up the multimeter as shown below.

(a) Identify the two errors the student has made.

2



Error 1:

Error 2:



MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

## 5. (continued)

- (b) The student is given a resistor with no colour markings.

Describe how the student would set up and use a multimeter to accurately measure the resistance of the resistor.

3

[Turn over

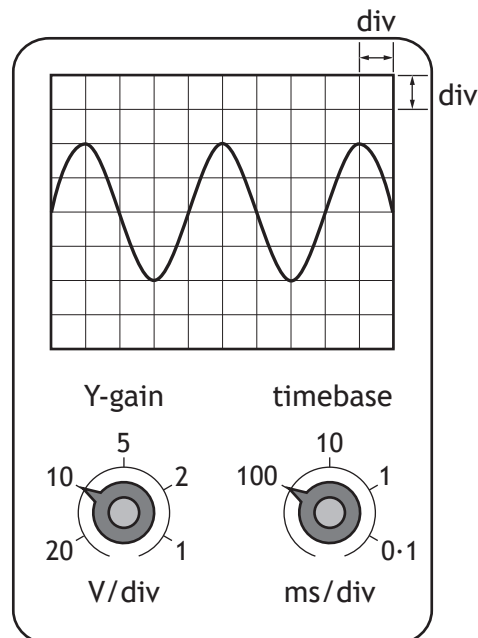


\* X 8 6 0 7 5 0 1 1 1 \*

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

6. An oscilloscope is connected to show the output trace from a signal generator. The trace is shown on the screen. The Y-gain and timebase settings are also shown.



- (a) Determine the frequency of the signal.  
*Space for working and answer*

3



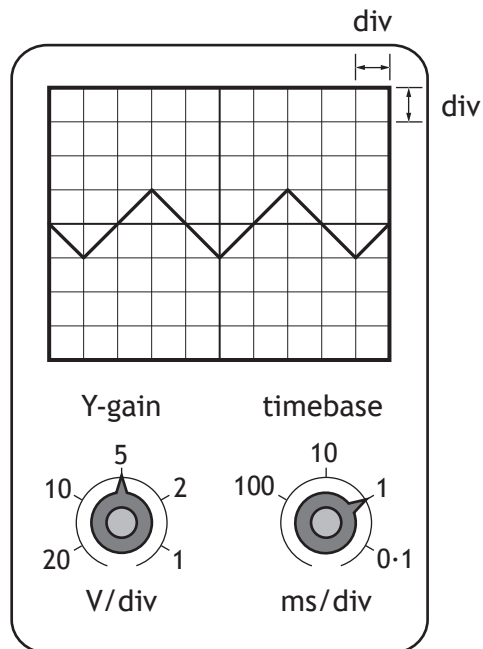
\* X 8 6 0 7 5 0 1 1 2 \*

MARKS

DO NOT  
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MARGIN

## 6. (continued)

The output from the signal generator was changed to produce the trace shown below.



(b) State whether the signal is analogue or digital.

1

[Turn over

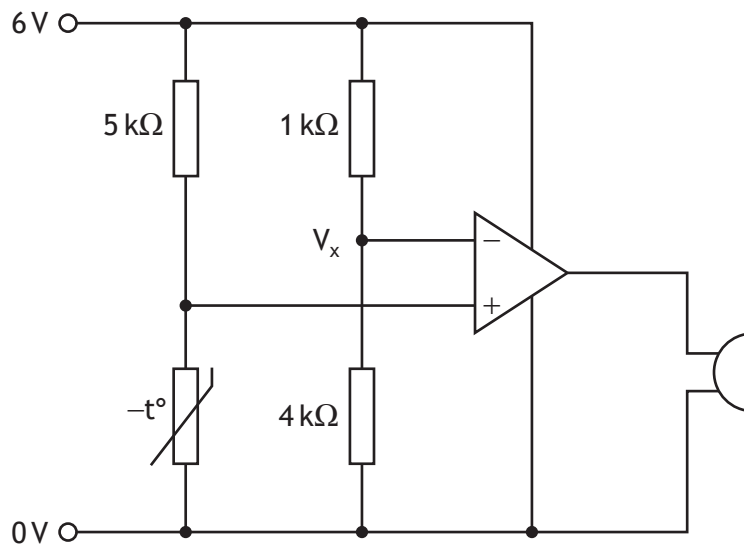


Question			Expected response	Max mark	Additional guidance
5.	(a)		<p>Error: meter on incorrect scale/ range/setting (1 mark)</p> <p>Error: probe 1 in wrong socket (1 mark)</p> <p>OR</p> <p>probe 1 should be in VΩmA socket</p> <p>OR</p> <p>middle/centre socket</p>	2	<p>Accept Meter on ampere/current scale</p> <p>Multi-meter should be set to <math>V_{\overline{\sim}}</math> or <math>V_{\sim}</math></p> <p>Probe must be identified as probe 1</p>
	(b)		<p>Connect probe 1 to middle socket/ VΩmA socket.</p> <p>(Probe 2 to the COM socket) (1 mark)</p> <p>Set scale to Ω/ohms/resistance (1 mark)</p> <p>Start at highest resistance range and work down until display reads 1 then go up one range. (1 mark)</p>	3	<p>Accept range/scale as interchangeable</p> <p>Accept: probe 1 =&gt; COM Probe 2 =&gt; VΩmA</p> <p>Or until measured resistance is bigger than the next smallest scale/range</p>
6.	(a)		<p>Period <math>t = 400\text{ms}</math> or <math>0.4\text{s}</math> (1 mark)</p> <p><math>f = \frac{1}{T}</math> (1 mark)</p> <p><math>f = \frac{1}{0.4}</math> <math>f = 2.5\text{Hz}</math> (1 mark)</p>	3	<p>Must have unit</p> <p>If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula.</p> <p>If period incorrect then award a maximum of 1 mark for the formula.</p> <p>If milli omitted from the period of the wave, treat as a unit error and award a maximum of 2 marks, unless final answer is then quoted as 0.0025 kHz, in which case 3 marks may be awarded.</p>
	(b)		Analogue (signal)	1	

MARKS

DO NOT  
WRITE IN  
THIS  
MARGIN

7. A low temperature warning system is controlled using a LM741 comparator circuit as shown in the simulation below.



- (a) Calculate the reference voltage  $V_x$ .

3

*Space for working and answer*

- (b) State the resistance of the thermistor when the voltage across it is equal to the reference voltage  $V_x$ .

1

- (c) Describe how this circuit works.

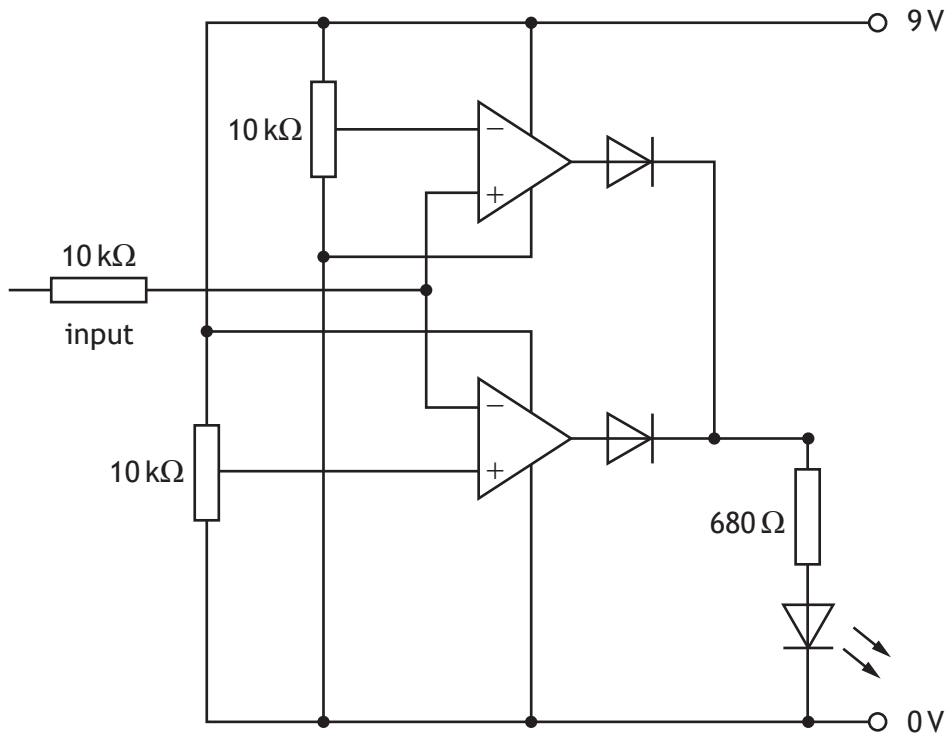
3



\* X 8 6 0 7 5 0 1 1 4 \*

MARKS  
DO NOT  
WRITE IN  
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MARGIN

8. A student simulated the circuit shown below.



(a) Complete the following table by giving **three** pre-power up checks for this circuit.

3

Pre-power up checklist
Check both IC's orientation

[Turn over



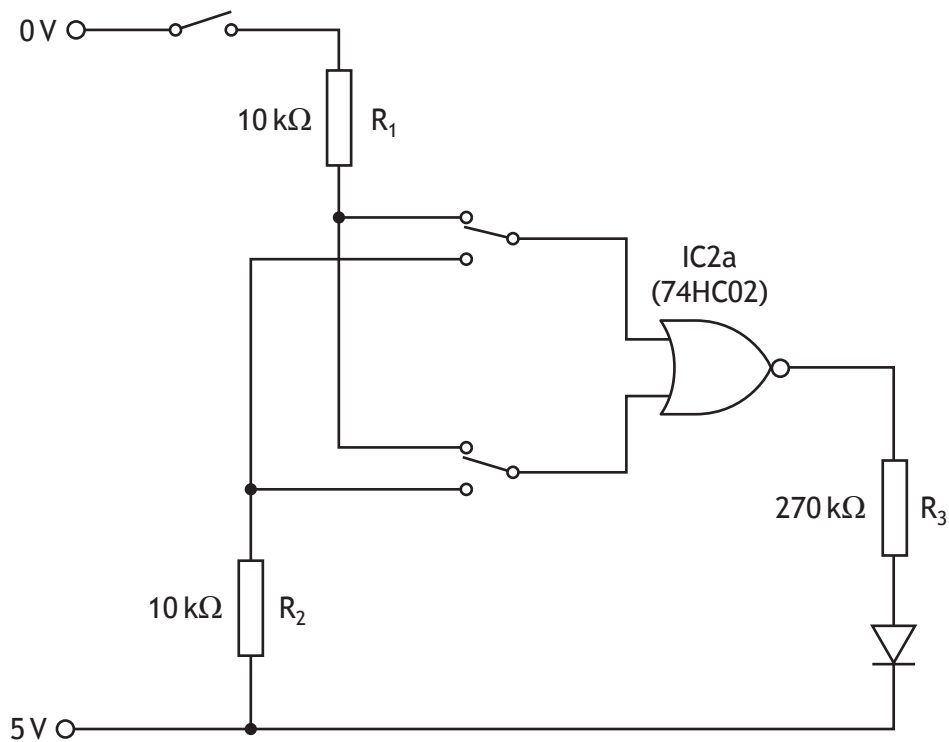
## 8. (continued)

- (b) A student also produced a simulation of a circuit to logic test a single AND gate using a LED as the output device.

However the simulation does not work as specified.

Identify **the four** errors in the simulation below.

4



Error 1:

Error 2:

Error 3:

Error 4:



\* X 8 6 0 7 5 0 1 1 6 \*

Question			Expected response	Max mark	Additional guidance
7.	(a)		$V_x = \frac{R_2}{R_1 + R_2} \times V_s \quad (1 \text{ mark})$ $V_x = \frac{4000}{5000} \times 6 \quad (1 \text{ mark})$ $V_x = 4.8V \quad (1 \text{ mark})$	3	Accept (4/5) x 6.  1 mark for Ohm's Law anywhere. 1 mark for both substitutions. 1 mark for final answer including unit.  Or by voltage ratio method.  If correct answer given with no working award 3 marks.
	(b)		20K or 20kΩ or 20,000Ω	1	Must have unit or be in R notation
	(c)		As temperature decreases thermistor resistance increases. (1 mark)  As thermistor resistance increases the voltage across the thermistor increase. (1 mark)  When voltage across thermistor = Vx then LM741/comparator/IC/op amp switches on (1 mark)	3	Accept V ref = Vx = trigger voltage = switch on voltage = threshold (voltage)  Accept buzzer/alarm sounds in place of LM741 switching on but not bell
8.	(a)		Any three from <ul style="list-style-type: none"> <li>• check diode orientation</li> <li>• check LED orientation</li> <li>• correct value of resistors</li> <li>• both ICs are the same type</li> <li>• both potentiometers are of the same type (linear or log)</li> <li>• both potentiometers have same maximum resistance</li> <li>• check power supply connected correctly/right way round</li> </ul>	3	Do not accept variable resistors.
	(b)		Voltage supply rails are reversed/wrong way around (1 mark)  Incorrect logic gate used (1 mark)  R <sub>3</sub> resistance too large (1 mark)  Using diode not LED (1 mark)	4	Accept using a NOR gate  Accept not using a LED  Not resistor too big/large  If power not identified then accept diode/led wrong way round

MARKS

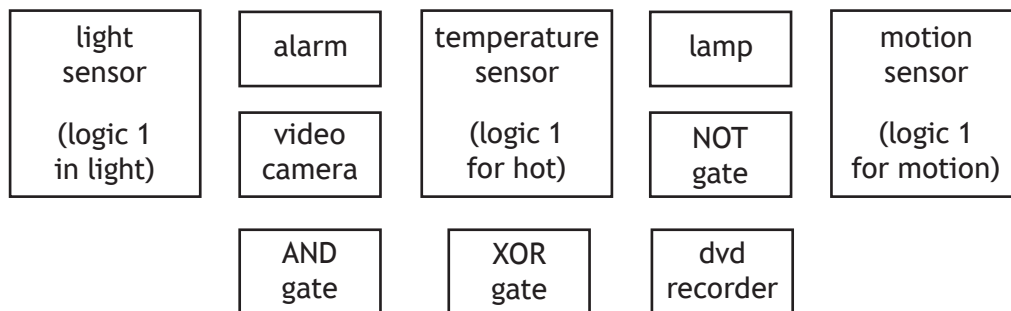
DO NOT  
WRITE IN  
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MARGIN

9. A security system for a house requires a lamp and an alarm to turn on when movement is detected outside the house. The security system only needs to operate at night.

Selecting from the elements given below, draw a block diagram of an electronic solution for the security system.

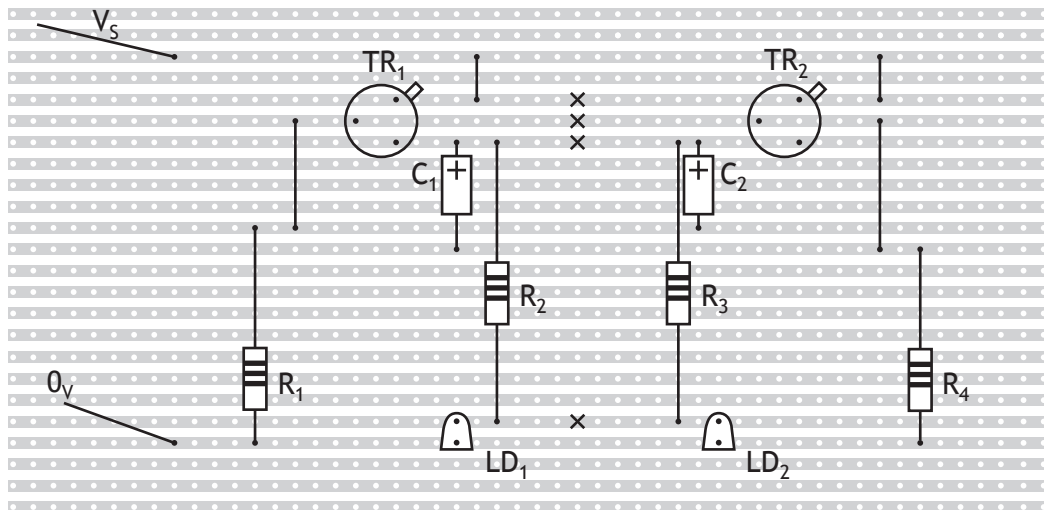
On your diagram, clearly indicate the input, process and output sections of your solution.

6



\* X 8 6 0 7 5 0 1 1 7 \*

10. The stripboard plan shows a **component (top) view** of a circuit with the following layout.



### Component data

$R_1$  and  $R_4$  – carbon film 2K2 0.25W

$R_2$  and  $R_3$  – carbon film 390R 0.25W

$C_1$  – 100 $\mu$ F **electrolytic** capacitor

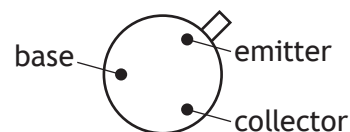
$C_2$  – 100 $\mu$ F **electrolytic** capacitor

$LD_1$  and  $LD_2$  5mm standard LED

$TR_1$  and  $TR_2$  – BC179 **pn**p bipolar transistors

X shows where a track has been cut

$TR_1$  and  $TR_2$  pin connections



Draw a circuit diagram for this circuit.

Each component must be labelled.

6



\* X 8 6 0 7 5 0 1 1 8 \*

Question		Expected response	Max mark	Additional guidance
9.		<p><b>1 mark</b> for selecting both inputs</p> <p><b>1 mark</b> for selecting correct gates</p> <p><b>1 mark</b> for selecting both outputs</p> <p><b>1 mark</b> for correctly linking inputs to gates</p> <p><b>1 mark</b> for linking AND gate to outputs</p> <p><b>1 mark</b> correctly identifying the three sections of the system diagram</p>	<b>6</b>	<div data-bbox="962 248 1460 584"> </div> <p>All selected elements must be shown as part of a system/block diagram. (arrows are NOT required on the connections).</p>
10.		<p>Both power rails labelled with nodes <b>(1 mark)</b></p> <p>Transistor positions and type (npn used) <b>(1 mark)</b></p> <p>Base to 0v via 2K2 resistors <b>(1 mark)</b></p> <p>Collector to 0v via 390R resistor with LED correct orientation <b>(1 mark)</b></p> <p>Both capacitor orientation and connections <b>(1 mark)</b></p> <p>All components labelled (either values or identifiers) <b>(1 mark)</b></p>	<b>6</b>	<div data-bbox="962 768 1460 1182"> </div> <p>If npn used and other connections are in comparable places then treat as repeated error and deduct 1 mark for transistor position/type</p> <p>Accept a mixture of identifiers and values.</p>

[END OF MARKING INSTRUCTIONS]