National 5 Practical Electronics Past Papers

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1 Intro

Much like the Higher and National 5 Physics Past Paper documents from Mr Davie and recently updated by Mr White, this document was created in order to make it easier to find past paper questions, both for teachers and students. I will add new past papers as they are issued. If you spot any mistakes, or want to suggest any improvements, send me an email at sputnikjoe77@gmail.com.

2 How to Use

The table on the next page contains links to questions sorted by topic and year. Clicking on a link will take you to that question. The marking instructions follow directly after each question. To return to the table click on Question Table at the top or bottom of any page. Trying to navigate the document without doing this is tedious.

Before starting any past paper questions I recommend that you have paper copies of the Relationships Sheet and Data Sheet to avoid wasting time.
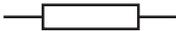
Topic	2017 SQP	2018	2019	2024	2025	Additional Paper
Circuit Symbols and Functions	1a	1a	1a	1a, 7b	1a	1a
Resistor Values	1b	1b	1b	1b	1b	1b, 1c
Cable & Wiring	2	2	2b		6	2
Series/Parallel Circuits	3	3	3, 5b	3	2, 3	3
Logic Gates	4	4	4	4	4	4
Logic Testing		5			7a	5
AC/DC	5	6	6	8	8	
Electromagnetism			2a			
Switching Circuits	6b, 7b	7a			9b	6, 9
Voltage Dividers	7a	7b			9a	
Special Circuits (Bi-stable, 555, Comparator)			7	5a, 9		8
Circuit Simulation/Testing	6a,c		8a	6, 7c	7b	7
Safety	9a			2		
Circuit Errors		8	5a, 8b	5b, 7a	5	
Circuit Cost		9				
Block Diagrams	8	10	9	10	10	10
Circuit/Layout Diagrams	9b	11	10	11	11	11

Total marks — 60

Attempt ALL questions

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

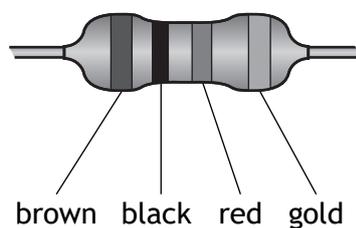   Complete the table for the missing entries. **3**

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

1. (continued)

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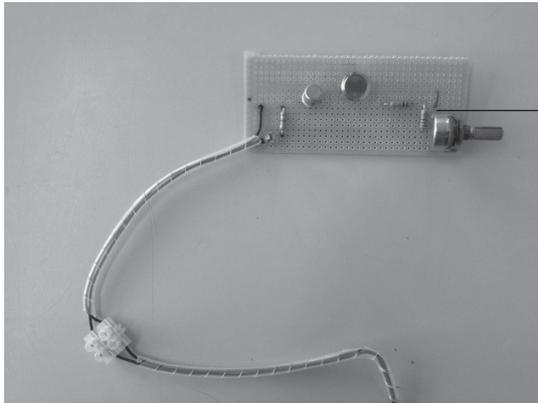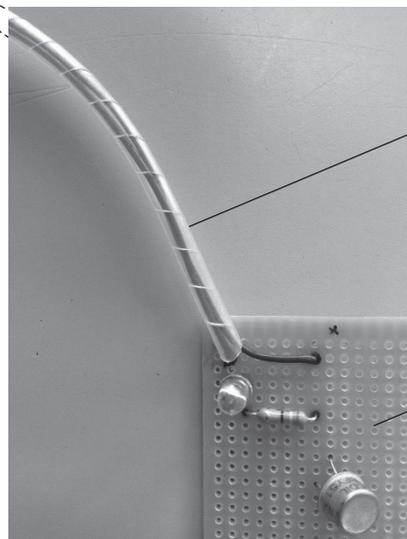

brown   black   red   gold

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.
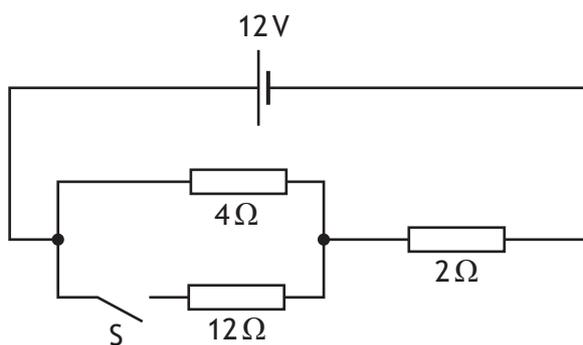
2

[Turn over

Marking instructions for each question

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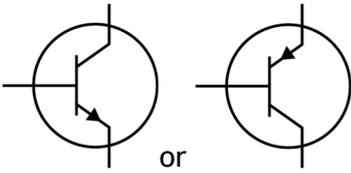
3. A student sets up a circuit as shown.

(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**

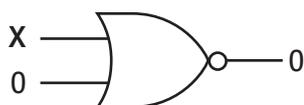**4.** Logic gates are widely used in electronic circuits.

(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.

X ⎯⎯⎯⎮
        ⟩⊙⎯ 0
0 ⎯⎯⎯⎮

Determine the logic state at **X** that would produce the output shown. **1**

[Turn over

4. (continued)

(c)
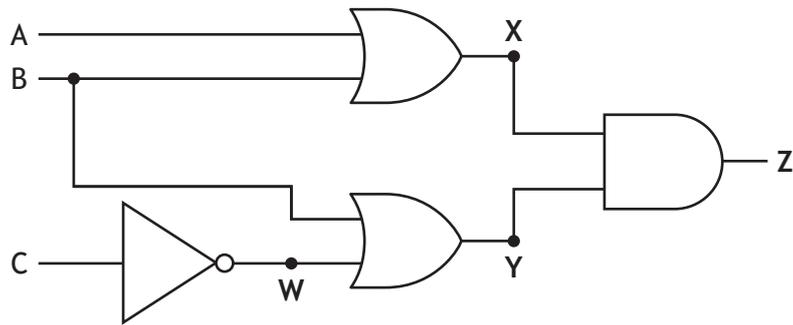
Complete the truth table for the circuit.

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*.)

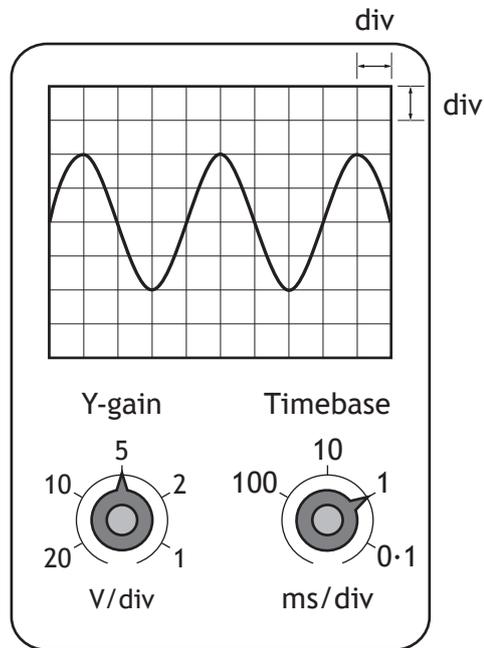| Question			Answer	Max mark	Additional guidance
3.	(a)	(i)	6 Ω	1	Unit required.
		(ii)	$V = IR$ 1 $12 = I \times 6$ 1 $I = 2$ A 1	3	Or consistent with (a)(i)
	(b)	(i)	$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ 1 $\dfrac{1}{R} = \dfrac{1}{4} + \dfrac{1}{12}$ 1 $R_T = 3$ Ω 1	3	$R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ is an acceptable alternative method. If wrong equation used, eg $R_T = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ then (0) marks Accept imprecise working towards a final answer. $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2} = \dfrac{1}{4} + \dfrac{1}{12} = 3\,\Omega$ accept
		(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> 1 mark for each correct column. Apply follow through between columns.	4	

MARKS

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.

div

div

Y-gain

Timebase

5

10 2

20 1

V/div

10

100 1

0·1

ms/div

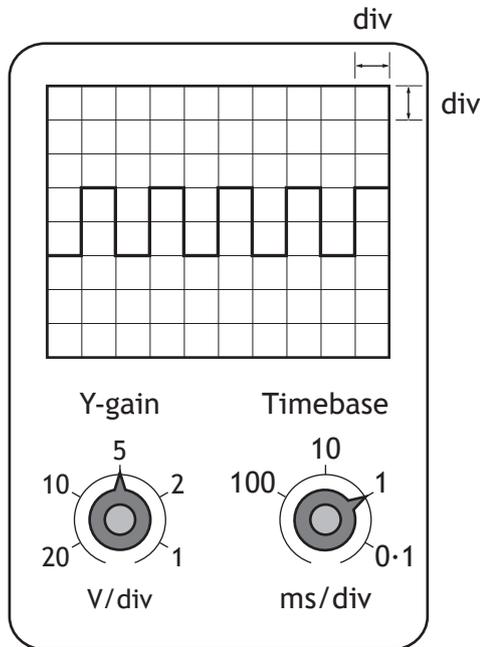Determine the peak voltage of the signal. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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**

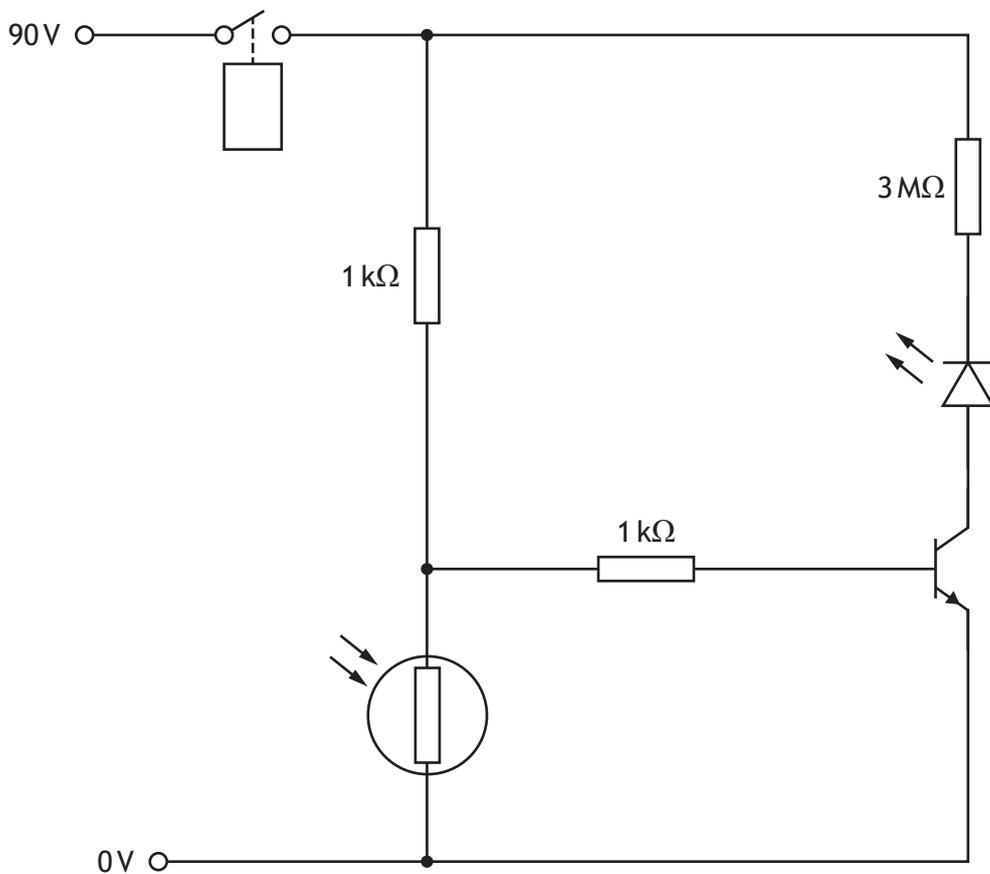(ii) Determine the frequency of the signal. **3**

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.
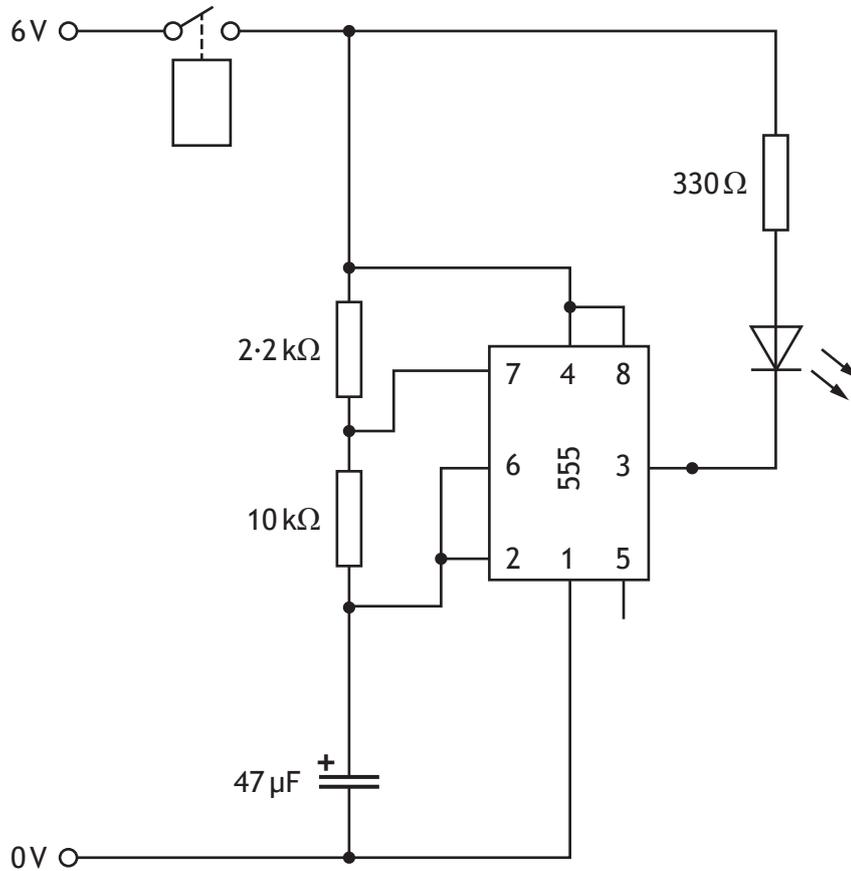

Identify the **three** errors in the circuit.

3

MARKS | DO NOT WRITE IN THIS MARGIN

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

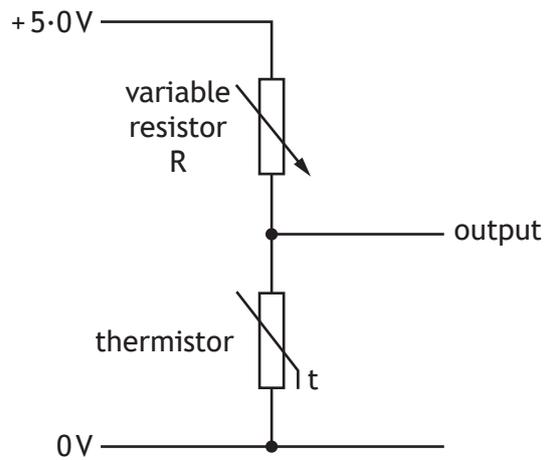| Pre-power up checklist |
|---|
| Check IC orientation |
| |
| |

| Question			Answer		Max mark	Additional guidance
5.	(a)		10 V		**1**	
	(b)	(i)	digital		**1**	
		(ii)	$T = (2 \times 1 \text{ ms} =) 2$ ms	1	**3**	If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula.
			$f = \dfrac{1}{T}$	1		If period incorrect then award a maximum of 1 mark for the formula.
			f = 500 Hz	1		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.
6.	(a)		to establish if the circuit works to improve the circuit design easily edited to try different combinations allows testing of sub-systems Any other suitable response. Any two for 1 mark each.		**2**	Not: allows you to cost the circuit.
	(b)		incorrect/too large supply voltage	1	**3**	
			protective resistance for LED is too large	1		
			LED connected wrong way round	1		
	(c)		orientation of capacitor orientation of LED supply voltage resistance values Any three for 1 mark each.		**3**	

MARKS

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.

```
            +5·0V ─────────┐
                           │
   variable  ╲        ┌────┴────┐
   resistor   ╲       │    ╲    │
      R               │     ╲   │
                      └────┬────┘
                           │
                           ●──────────── output
                           │
                      ┌────┴────┐
                      │    ╱    │
   thermistor ────────│   ╱     │
                      └──┬──┬────┘
                         │  t
               0V ───────●─────────────
```

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

resistance (Ω) vs *temperature (°C)*
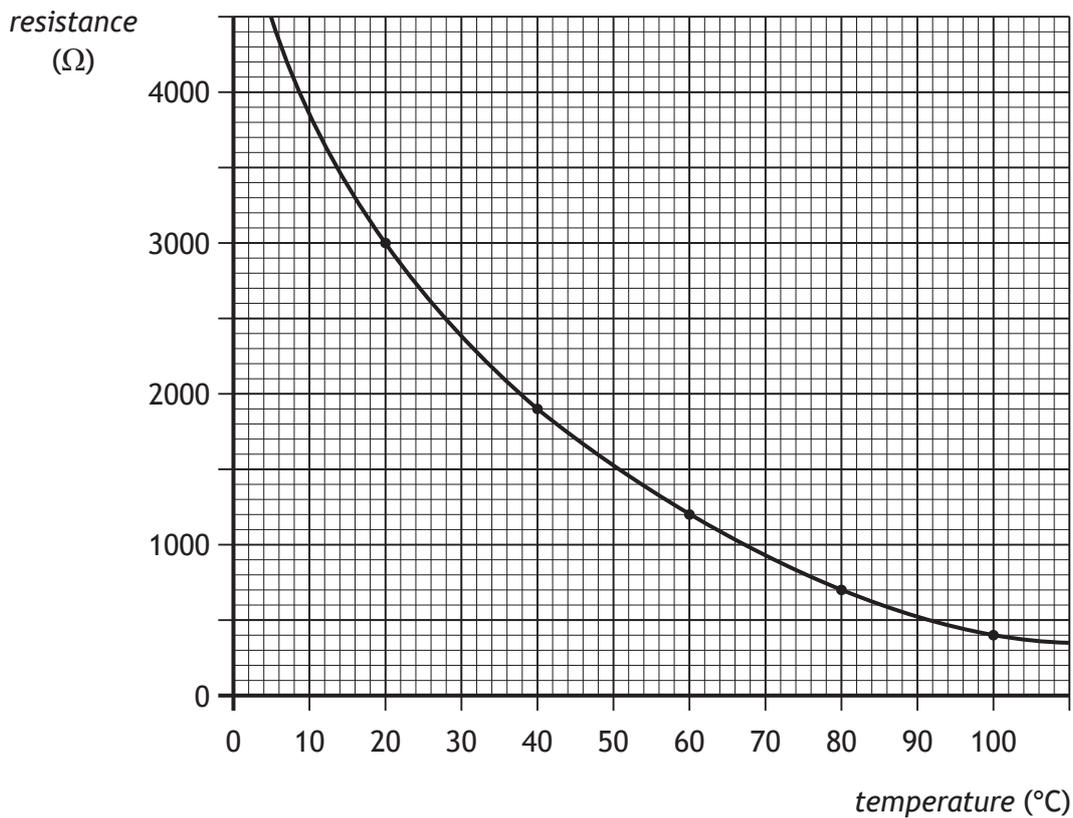
Use the graph to determine the resistance of the thermistor when the temperature is 60 °C.

1

[Turn over

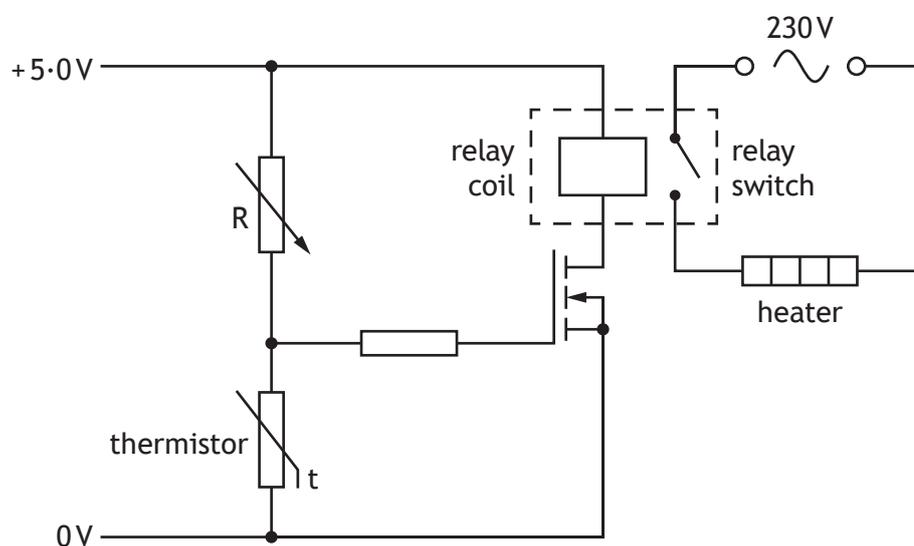**7. (a) (continued)**

      (ii) The variable resistor R is now set at a resistance of 800 Ω.

         Calculate the voltage across the thermistor when the temperature is 60 °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.
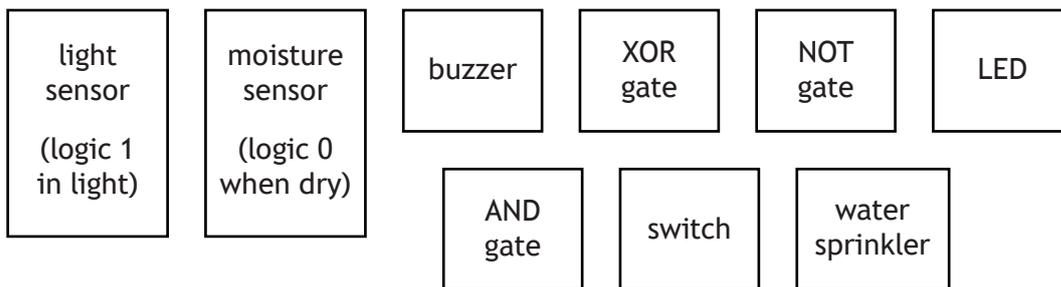
         Name this component.

       1

MARKS

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

| light sensor (logic 1 in light) | moisture sensor (logic 0 when dry) | buzzer | XOR gate | NOT gate | LED |

| AND gate | switch | water sprinkler |

| Question			Answer		Max mark	Additional guidance
7.	(a)	(i)	1200 Ω or 1k2		1	
		(ii)	$V_1 = \dfrac{R_1}{R_1 + R_2} \times V_S$	1	3	Or consistent with (a)(i)
			$V_1 = \dfrac{1200}{1200 + 800} \times 5 \cdot 0$	1		Using Ohm's law: $R_T (=1200+800) = 2000$
			$V_1 = 3$ V	1		$I = \dfrac{V}{R}$
						$I = \dfrac{5 \cdot 0}{2000}$
						$I = 2 \cdot 5 \times 10^{-3}$ A
						$V_1 = IR$
						$V_1 = 2 \cdot 5 \times 10^{-3} \times 1200$
						$V_1 = 3$ V
						1 mark for Ohm's Law relationship
						1 mark for all substitutions
						1 mark for final answer including unit
	(b)	(i)	Resistance of thermistor increases so voltage across it increases. 1		3	If transistor switching voltage is given as 0·7 V award a maximum of 2 marks.
			Transistor switches on at a certain voltage/2 V. 1			
			Relay activates and closes contacts in heater circuit. 1			
		(ii)	diode		1	
8.			1 mark for selecting both input devices		6	
			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			

page 09

MARKS | DO NOT WRITE IN THIS MARGIN

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

2

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

5
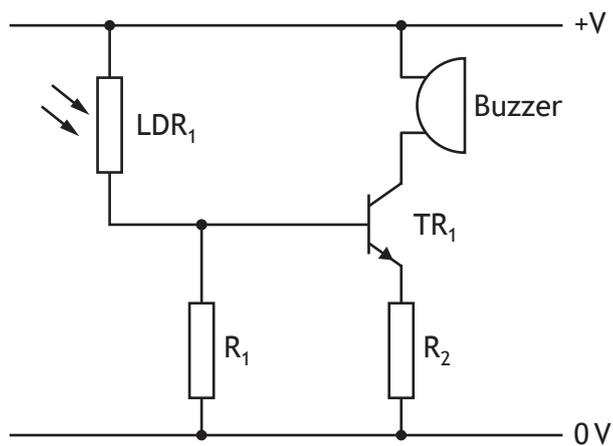
Component data

R_1 – carbon film 10 kΩ 0·25 W

R_2 – carbon film 1 kΩ 0·25 W
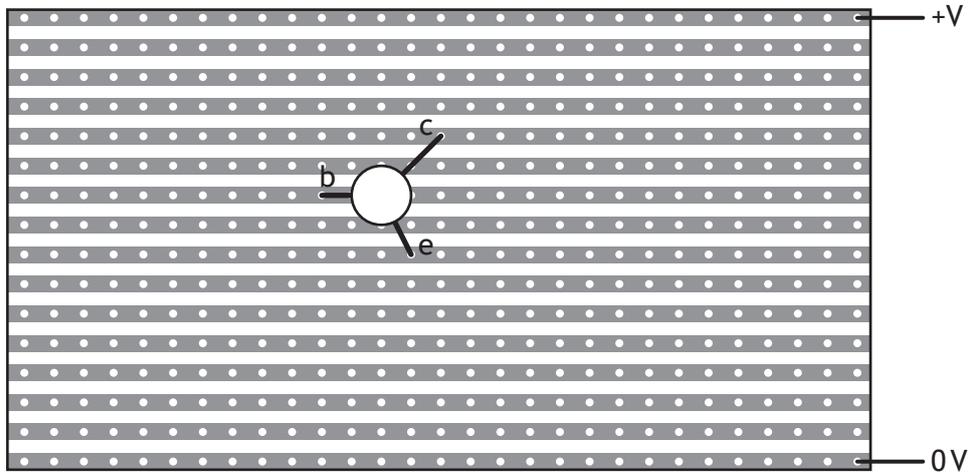
LDR_1 – ORP12

TR_1 – BC108 npn bipolar

Buzzer – 6 V dc

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]

MARKS | DO NOT WRITE IN THIS MARGIN

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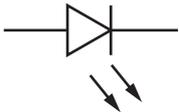
Name	Symbol	Function
electrolytic capacitor		stores charge
		emits light
relay		
741 operational amplifier (op-amp)		comparator
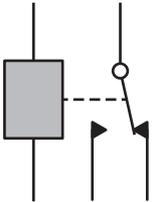
MARKS

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1. (continued)

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

| 1st band | 2nd band | multiplier | tolerance |
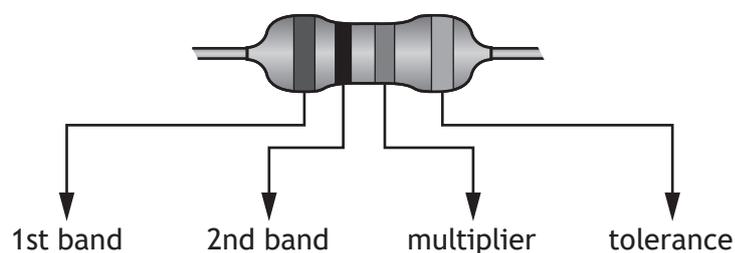
A student is comparing two resistors R_1 and R_2. The colour code for each resistor is given in the table below.

Resistor	1st band	2nd band	Multiplier	Tolerance
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**

1st band	2nd band	Multiplier	Tolerance
			gold

[Turn over

MARKS

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

2
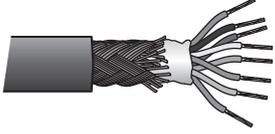
	Cable type	Typical use
	multi-strand	
	coaxial	

[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 Ω/ 12 kΩ / 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.
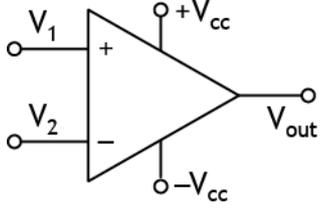
MARKS | DO NOT WRITE IN THIS MARGIN

3. A student sets up the circuit shown.
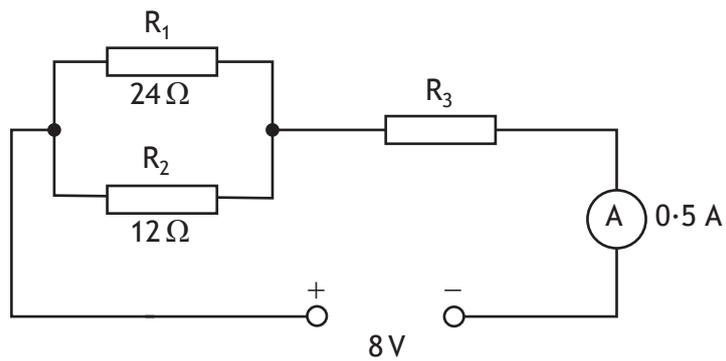
(a) Calculate the total resistance of the circuit. **3**

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

MARKS

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)**	**3**	
			$8 = 0 \cdot 5 \times R$	**(1 mark)**		
			$R = 16 \ \Omega$	**(1 mark)**		Accept 16R
	(b)		$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$	**(1 mark)**	**3**	$R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ is an acceptable alternative method.
			$\dfrac{1}{R_T} = \dfrac{1}{24} + \dfrac{1}{12}$	**(1 mark)**		If wrong equation used, eg $R_T = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ then (0) marks.
			$R_T = 8 \ \Omega$	**(1 mark)**		Accept imprecise working towards a final answer. $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2} = \dfrac{1}{12} + \dfrac{1}{24} = 8 \ \Omega$
						accept
						Accept 8R
	(c)		$R_3 = 8 \ \Omega$		**1**	Or consistent with (a) and (b). Accept 8R
	(d)		$V_3 = 4 \ V$		**1**	Or consistent with (a), (b), and (c).
	(e)		$P = \dfrac{V^2}{R}$	**(1 mark)**	**3**	Or consistent with (a), (b), (c), and (d).
			$P = \dfrac{4^2}{8}$	**(1 mark)**		$P = IV$ **1** $P = 0 \cdot 5 \times 4$ **1** $P = 2 \ W$ **1**
			$P = 2 \ W$	**(1 mark)**		Or $P = I^2 R$ **1** $P = 0 \cdot 5^2 \times 8$ **1** $P = 2 \ W$ **1**

MARKS | DO NOT WRITE IN THIS MARGIN

4. Logic gates are widely used in electronic circuits.
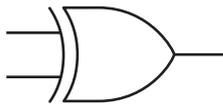
(a) Complete the truth table for an OR gate.   **1**

A	B	Output
0	0	
0	1	
1	0	
1	1	

(An additional truth table, if required, can be found on *page 24*.)
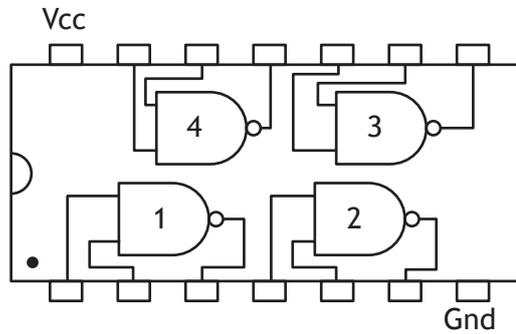
(b) Name the logic gate shown below.   **1**

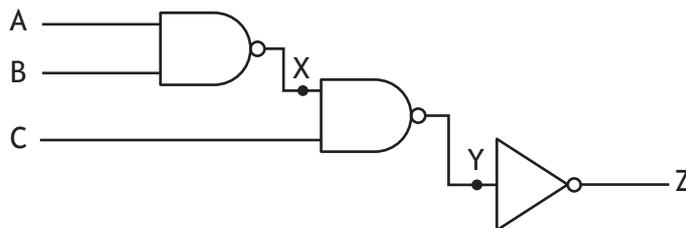MARKS | DO NOT WRITE IN THIS MARGIN

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) | | | | | | | | 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)			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
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

5.			Connect red wire of probe to V_{supply} and black wire to 0 V or equivalent. **(1 mark)** Place the probe tip onto circuit at selected point. **(1 mark)** Red LED lights. **(1 mark)**	3	Do not accept: connect the probe to the supply rails (on its own). 3 independent marks

MARKS | DO NOT WRITE IN THIS 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.

Crocodile clips for
supply connections

Black wire   Red wire

Red LED

Green LED

Metal probe

Hi Lo TTL CMOS MEM Pulse
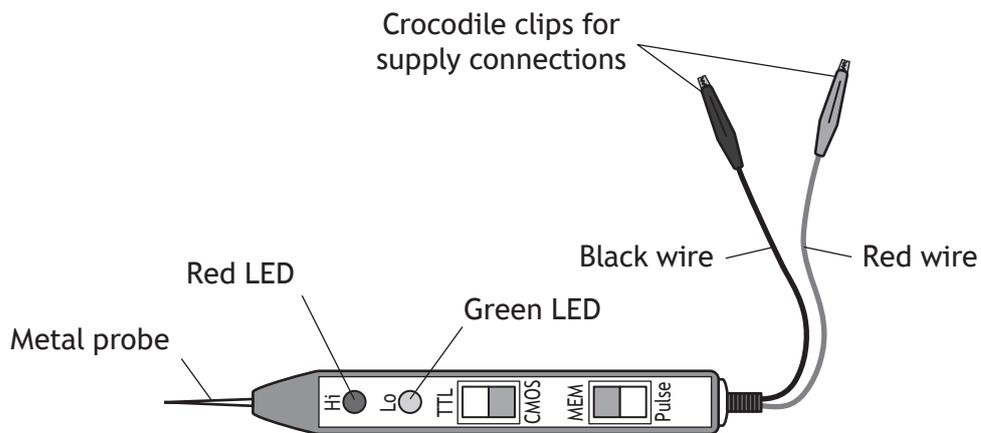
Describe how to connect and use the logic probe to test the inputs and outputs of the chip.

In your answer include how a logic 1 is detected.   **3**
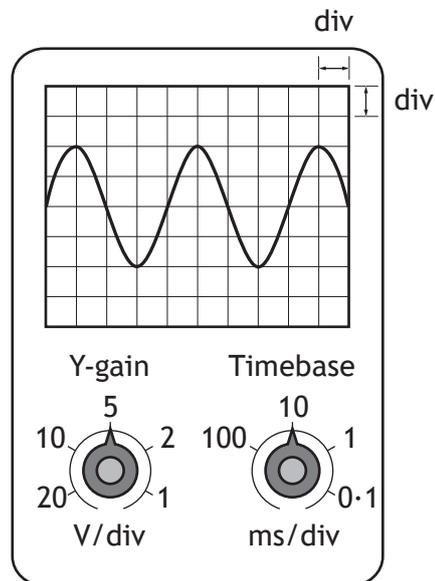
MARKS
DO NOT WRITE IN THIS MARGIN

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.

div

div

Y-gain | Timebase
5 | 10
10 ⟋ 2 | 100 ⟋ 1
20 ⟍ 1 | 0·1
V/div | ms/div

Determine the frequency of the signal. **3**

Space for working and answer

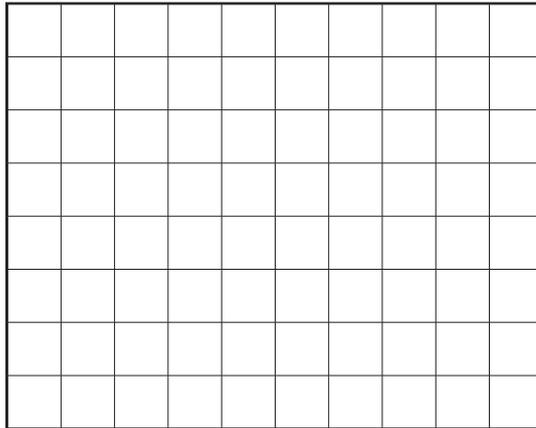MARKS | DO NOT WRITE IN THIS MARGIN

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.

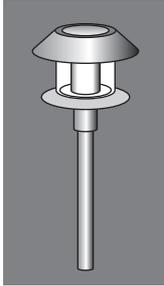Draw the new trace that would be shown on the screen. **1**

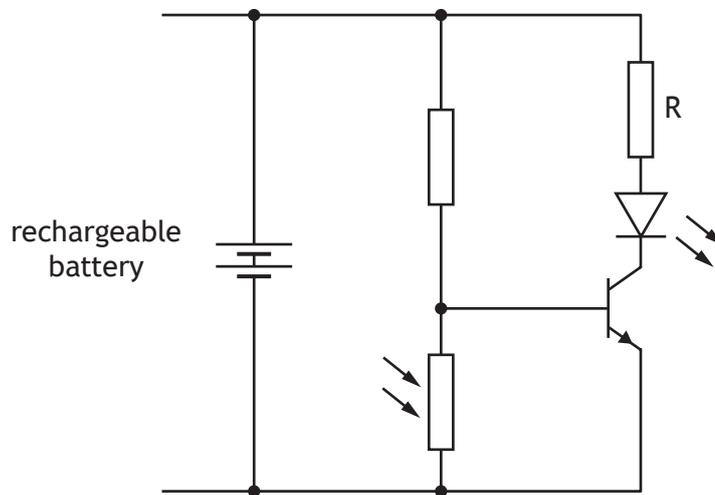(An additional diagram, if required, can be found on *page 24*.)

[Turn over

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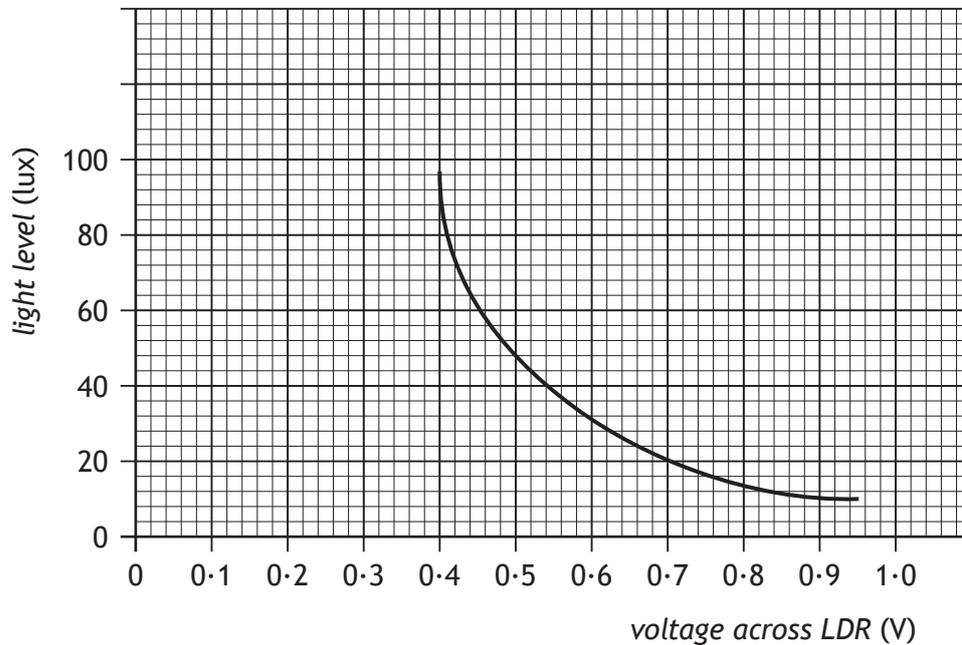

(a) The LED is switched on using the following circuit.

rechargeable battery

R

MARKS | DO NOT WRITE IN THIS 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
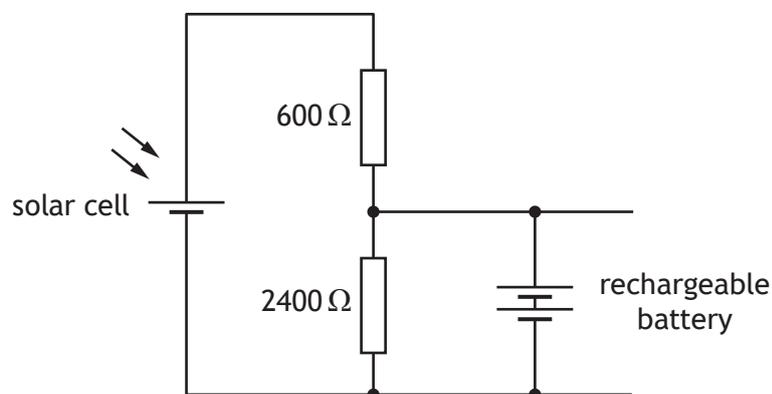
MARKS | DO NOT WRITE IN THIS MARGIN

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 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)** $$f = \frac{1}{T} \qquad \textbf{(1 mark)}$$ $f = 25 \text{ Hz}$ **(1 mark)**	**3**	If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula. If period incorrect then award a maximum of 1 mark for the formula. 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.
	(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)		$$V_2 = \frac{R_2}{R_1 + R_2} \times V_S \qquad \textbf{(1 mark)}$$ $$V_2 = \frac{2400}{600 + 2400} \times 1 \cdot 5 \quad \textbf{(1 mark)}$$ $V_2 = 1 \cdot 2 \text{ V}$ **(1 mark)**	**3**	$V = IR$ $1 \cdot 5 = I \times 3000$ $I = 5 \times 10^{-4}$ (A) $V = IR$ $V = 5 \times 10^{-4} \times 2400$ $V = 1 \cdot 2$ V 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.

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.
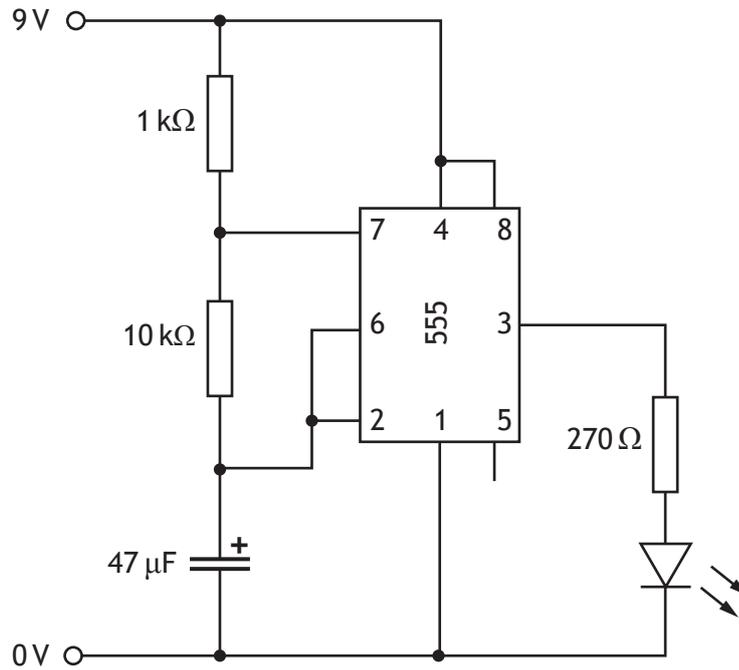
4
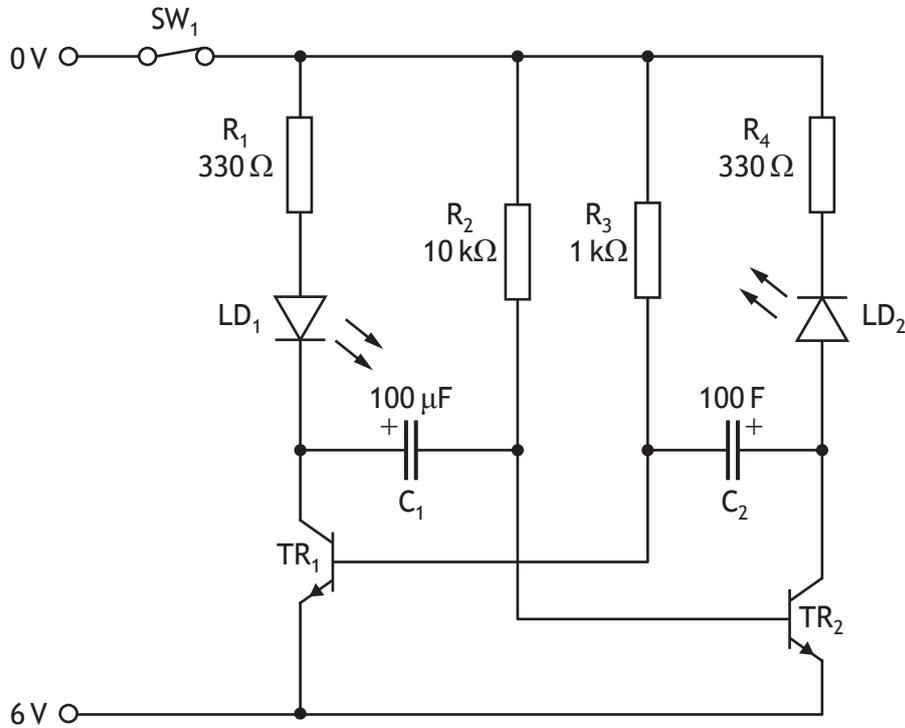
Error 1:

Error 2:

Error 3:

Error 4:

[Turn over

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 μF	16 V	CP-0555	10p
	47 μF	16 V	CP-0566	18p
	47 μF	6 V	CP-0588	10p
	47 μF	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 μF	16 V	EC 798	10p
	47 μF	16 V	EC 799	14p
	47 μF	6 V	EC 800	10p
	47 μF	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

Question			Expected response				Max mark	Additional guidance
8.			Power supply reversed/ wrong way round. **(1 mark)** LD_2 wrong polarity/wrong way round. **(1 mark)** C_2 value incorrect/too big/ different. **(1 mark)** R_2 / R_3 value incorrect/ different. **(1 mark)**				4	Errors can be listed in any order. Battery not accepted
9.							5	1 mark for each correct row.

Table for Question 9:

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.

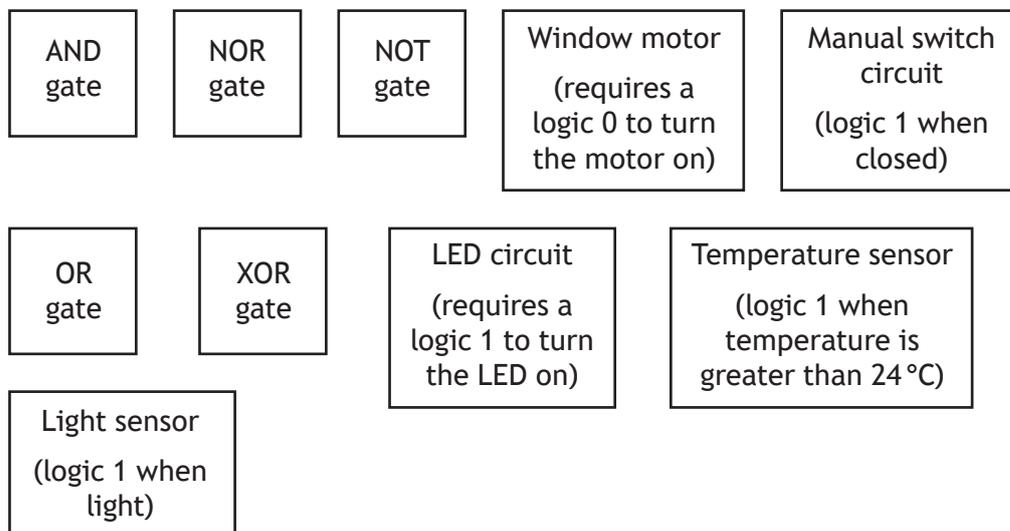If the temperature exceeds 24 °C this turns on a motor to open a window.

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

| AND gate | NOR gate | NOT gate | Window motor (requires a logic 0 to turn the motor on) | Manual switch circuit (logic 1 when closed) |

| OR gate | XOR gate | LED circuit (requires a logic 1 to turn the LED on) | Temperature sensor (logic 1 when temperature is greater than 24 °C) |

| Light sensor (logic 1 when light) |

Question	Expected response	Max mark	Additional guidance
10.	**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 to gates. **1 mark** for correctly linking the outputs to the gates. **1 mark** for correctly identifying the three sections of the system diagram. 	6	All selected elements must be shown as part of a system/block diagram. (arrows are NOT required on the connections).
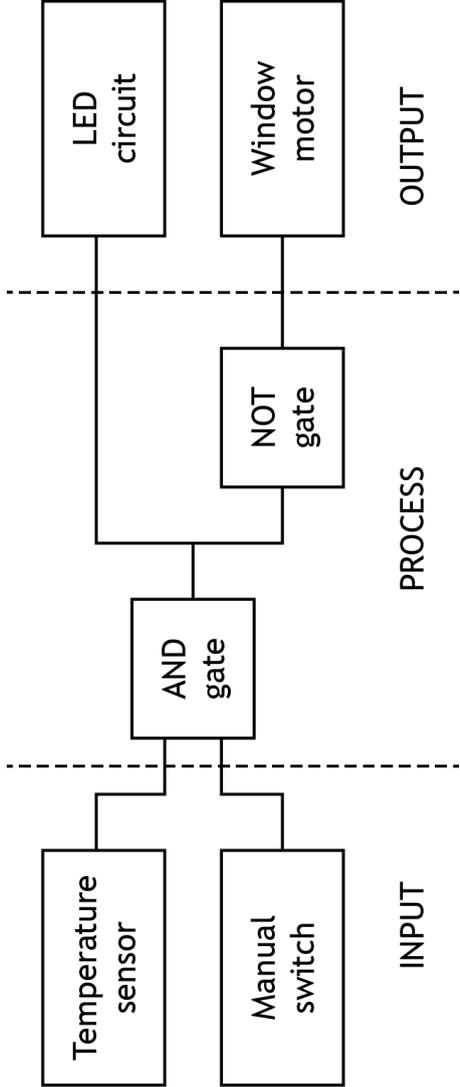
11. The following PCB layout shows a circuit with the following component data.
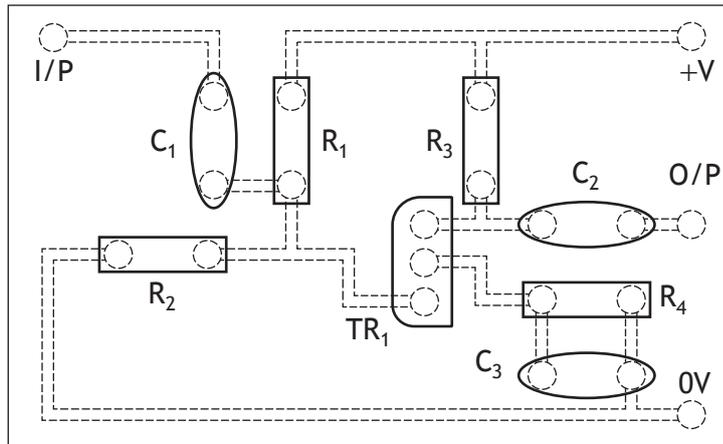
Component data

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 µF

C_2 — 0·1 µF

C_3 — 10 µF

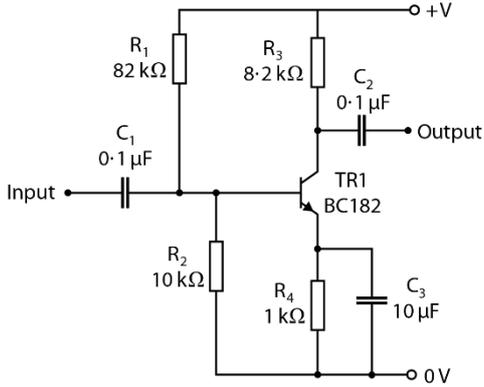TR_1 — BC182 npn bipolar

TR_1 pin connections

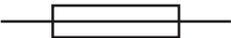Draw a circuit diagram for this circuit.

Each component must be labelled.

6

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

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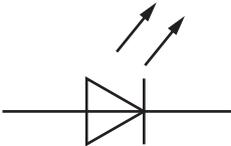
Component name	Symbol	Function
Light emitting diode		Emits light indicating a current flow
MOSFET transistor		
Motor		Converts electrical energy to kinetic energy
		To protect wiring from too much current

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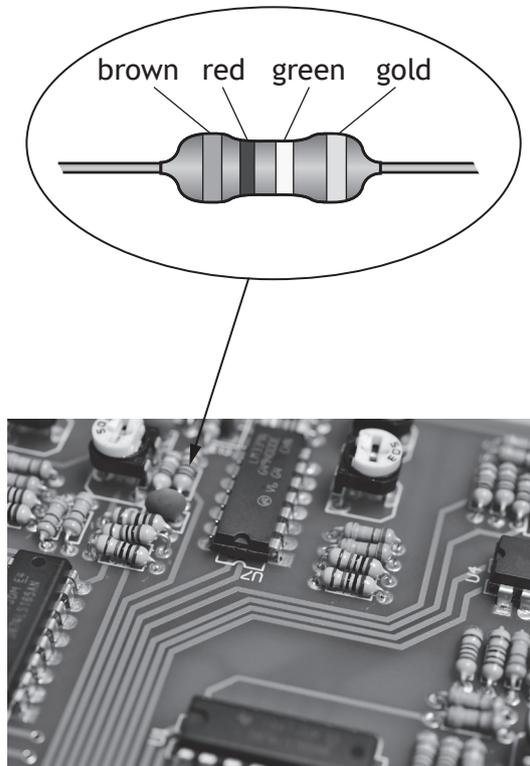
Use the information in the data sheet to answer the questions below.

(i) Determine the resistance of the resistor. **1**

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

Determine the minimum and maximum resistance of the resistor. **2**

MARKS | DO NOT WRITE IN THIS 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.
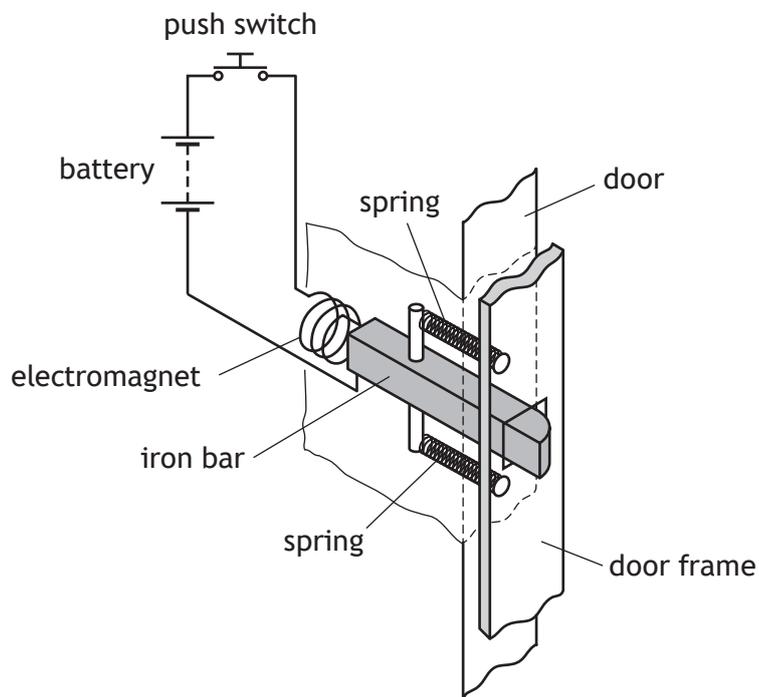
(a) Explain how this part of the system operates to unlock the door. **2**

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

Marking instruction for each question

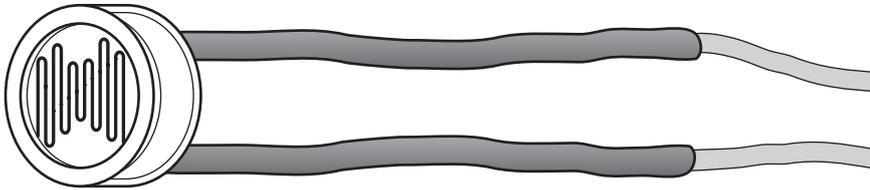| Question			Expected response	Max mark	Additional guidance
1.	(a)		Switch electrical **(1 mark)** **(1 mark)** FUSE **(1 mark)**	3	
	(b)	(i)	1M2 **OR** 1·2MΩ **OR** 1,200,000Ω	1	Also accept scientific notation with unit
		(ii)	Minimum 588Ω **OR** 588R **(1 mark)** Maximum 612Ω **OR** 612R **(1 mark)**	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

3. A circuit diagram is shown below.
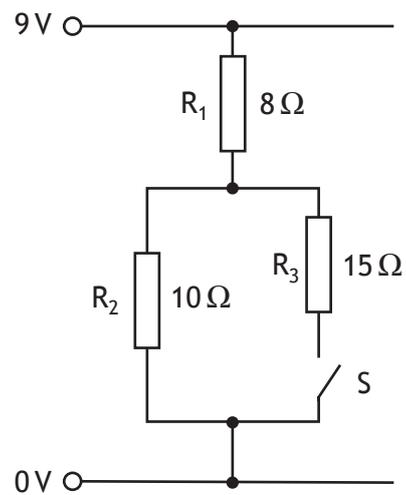
Switch S is **open.**

(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

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

Question			Expected response		Max mark	Additional guidance
3.	(a)	(i)	18Ω		1	Accept 18*R*
		(ii)	$V = IR$	**(1 mark)**	3	Accept answer consistent with 3(a)(i)
			$9 = I \times 18$	**(1 mark)**		Answer must have unit
			$I = 0.5\ A$	**(1 mark)**		
		(iii)	$P = I^2 R$	**(1 mark)**	3	Accept answer consistent with 3(a)(ii)
			$P = 0.5^2 \times 8$	**(1 mark)**		Answer must have unit
			$P = 2W$	**(1 mark)**		Accept P=IV =v2/R if full working given
	(b)		$\dfrac{1}{R_T} = \dfrac{1}{R_2} + \dfrac{1}{R_3}$	**(1 mark)**	3	$R_T = \dfrac{R_2 R_3}{R_2 + R_3}$ Is an acceptable alternative method
			$\dfrac{1}{R_T} = \dfrac{1}{10} + \dfrac{1}{15}$	**(1 mark)**		If wrong equation used, eg
			$R_T = 6\Omega$	**(1 mark)**		$R_T = \dfrac{1}{R_2} + \dfrac{1}{R_3}$ then (0) marks.
						Accept imprecise working towards a final answer.
						$\dfrac{1}{R_T} = \dfrac{1}{R_2} + \dfrac{1}{R_3} = \dfrac{1}{15} + \dfrac{1}{10} = 6\Omega$ accept
						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

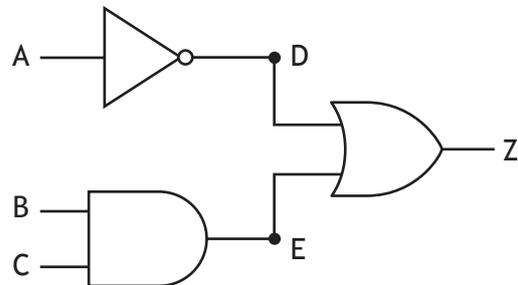Name the logic gate that produces this truth table.

1

MARKS DO NOT WRITE IN THIS MARGIN

4. (continued)

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

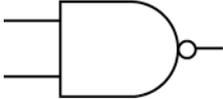(c) Complete the truth table for the logic circuit shown below.

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

Question			Expected response						Max mark	Additional guidance
4.	(a)								**1**	
	(b)		NOR (gate)						**1**	
	(c)								**3**	1 mark per column Apply follow through between columns

For question 4(c):

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

MARKS

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**
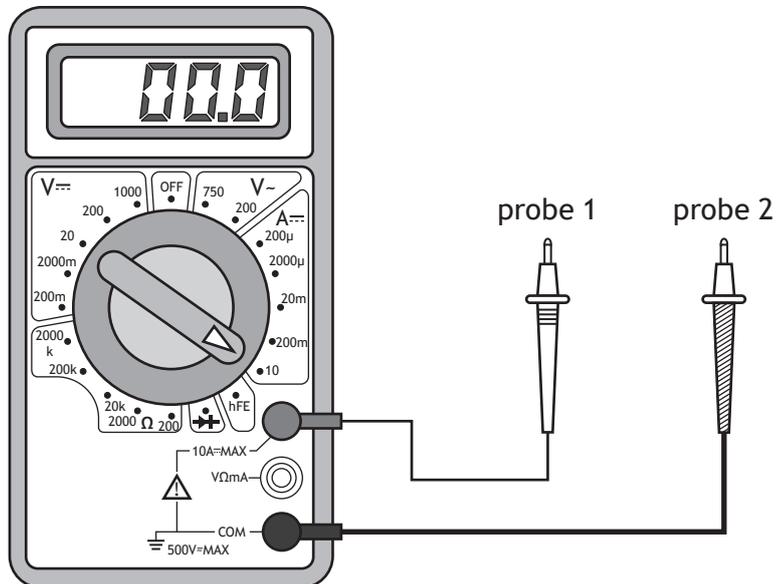
Error 1:

Error 2:

MARKS

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

6. An oscilloscope is connected to show the output trace from a signal generator.

The trace is shown on the screen.
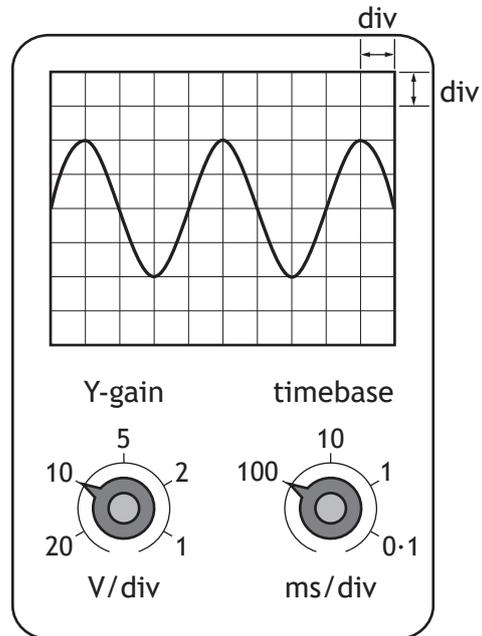
The Y-gain and timebase settings are also shown.

(a) Determine the frequency of the signal.   **3**

Space for working and answer

MARKS

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

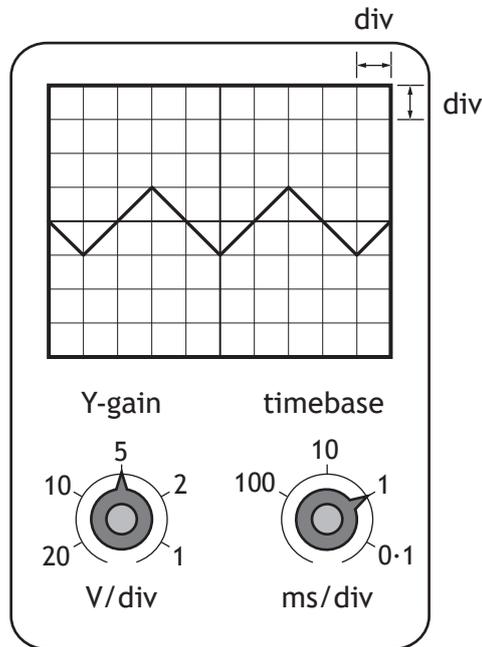|	Question		Expected response	Max mark	Additional guidance
5.	(a)		Error: meter on incorrect scale/ range/setting **(1 mark)** Error: probe 1 in wrong socket **(1 mark)** **OR** probe 1 should be in VΩmA socket **OR** middle/centre socket	2	Accept Meter on ampere/current scale Multi-meter should be set to V⁼ or V~ Probe must be identified as probe 1
	(b)		Connect probe 1 to middle socket/ VΩmA socket. (Probe 2 to the COM socket) **(1 mark)** Set scale to Ω/ohms/resistance **(1 mark)** Start at highest resistance range and work down until display reads 1 then go up one range. **(1 mark)**	3	Accept range/scale as interchangeable Accept: probe 1 => COM Probe 2 => VΩmA Or until measured resistance is bigger than the next smallest scale/range
6.	(a)		Period t = 400ms or 0·4s **(1 mark)** $f = \dfrac{1}{T}$ **(1 mark)** $f = \dfrac{1}{0 \cdot 4}$ $f = 2 \cdot 5 Hz$ **(1 mark)**	3	Must have unit If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula. If period incorrect then award a maximum of 1 mark for the formula. 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.
	(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.
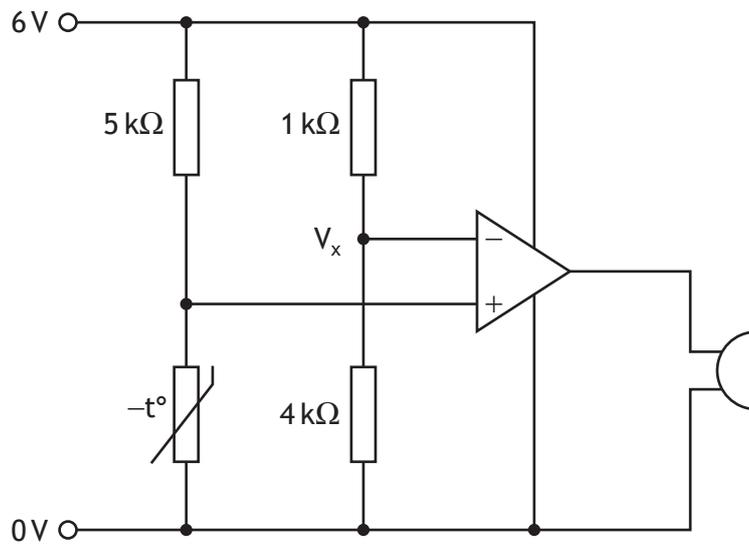
(a) Calculate the reference voltage V_x.   **3**

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**

MARKS | DO NOT WRITE IN THIS MARGIN

8. A student simulated the circuit shown below.
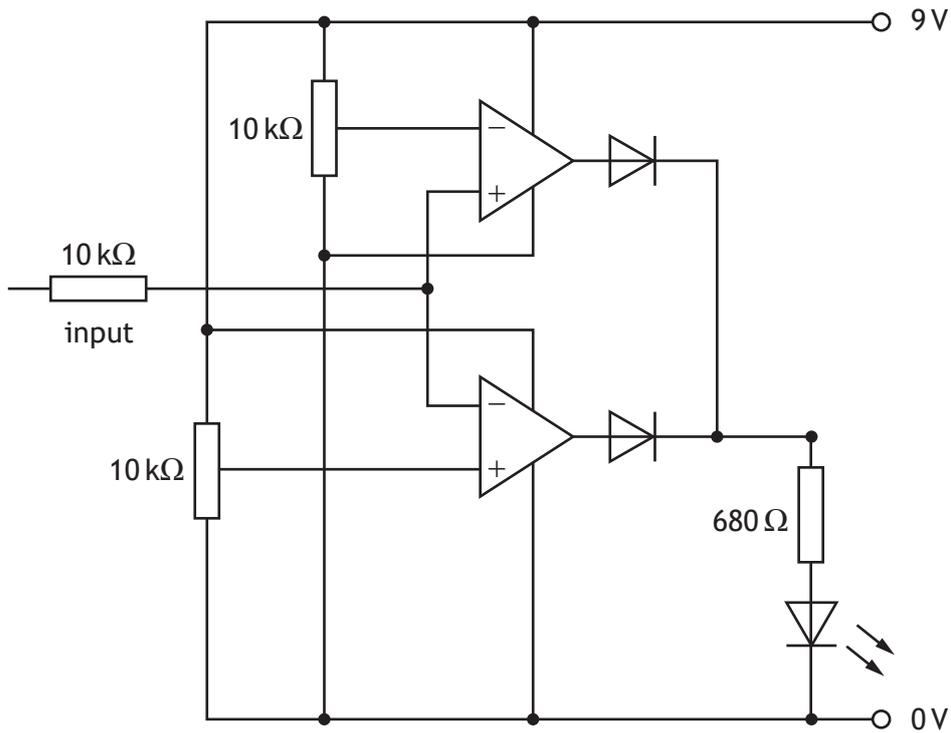
(a) Complete the following table by giving **three** pre-power up checks for this circuit.

3

Pre-power up checklist
Check both IC's orientation

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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:

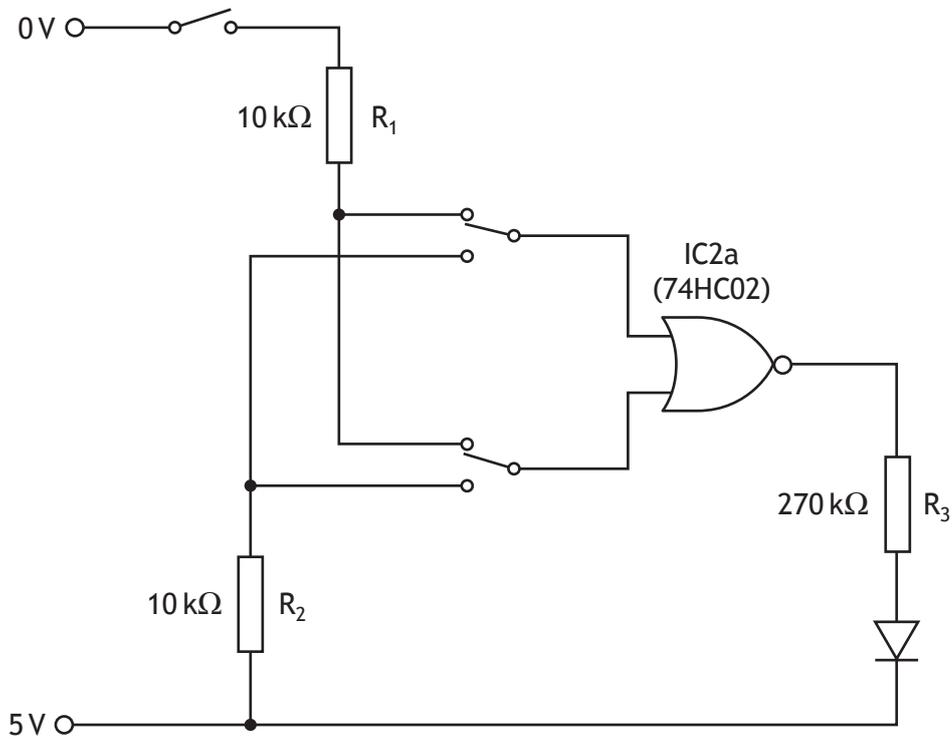| Question			Expected response	Max mark	Additional guidance
7.	(a)		$V_x = \dfrac{R_2}{R_1 + R_2} \times V_S$ **(1 mark)** $V_x = \dfrac{4000}{5000} \times 6$ **(1 mark)** $V_x = 4.8V$ **(1 mark)**	3	Accept (4/5) x 6. 1 mark for Ohm's Law anywhere. 1 mark for both substitutions. 1 mark for final answer 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 • check diode orientation • check LED orientation • correct value of resistors • both ICs are the same type • both potentiometers are of the same type (linear or log) • both potentiometers have same maximum resistance • check power supply connected correctly/right way round	3	Do not accept variable resistors.
	(b)		Voltage supply rails are reversed/ wrong way around **(1 mark)** Incorrect logic gate used **(1 mark)** R3 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 THIS 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

light sensor (logic 1 in light)	alarm	temperature sensor (logic 1 for hot)	lamp	motion sensor (logic 1 for motion)
	video camera		NOT gate	
	AND gate	XOR gate	dvd recorder	
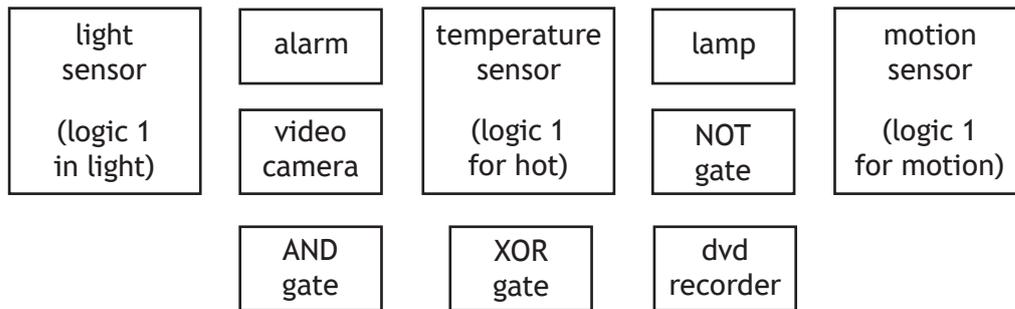
10. The stripboard plan shows a **component (top) view** of a circuit with the following layout.
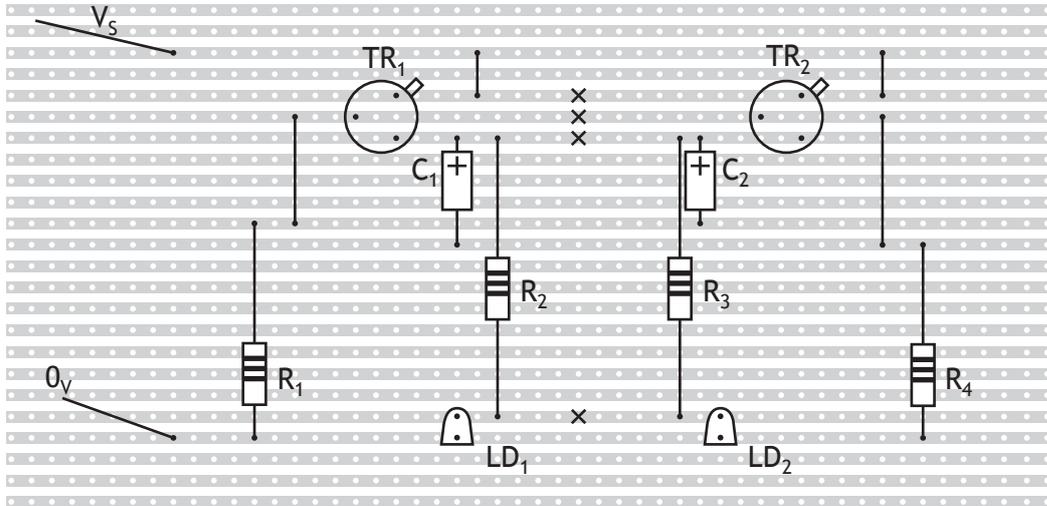
Component data

R_1 and R_4 – carbon film 2K2 0·25W

R_2 and R_3 – carbon film 390R 0·25W

C_1 – 100μF **electrolytic** capacitor

C_2 – 100μF **electrolytic** capacitor

LD_1 and LD_2 5mm standard LED

TR_1 and TR_2 – BC179 **pnp** 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

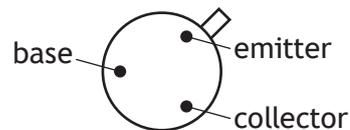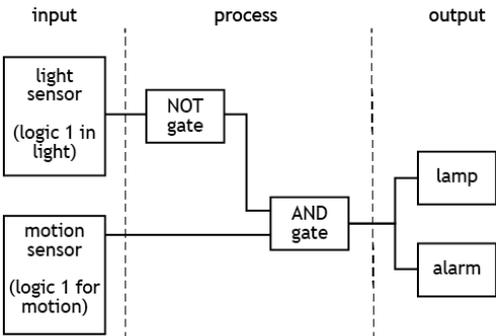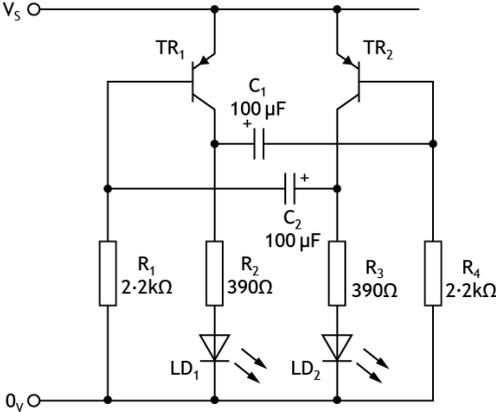| Question	Expected response	Max mark	Additional guidance
9.	**1 mark** for selecting both inputs **1 mark** for selecting correct gates **1 mark** for selecting both outputs **1 mark** for correctly linking inputs to gates **1 mark** for linking AND gate to outputs **1 mark** correctly identifying the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

[END OF MARKING INSTRUCTIONS]

page 11

MARKS | DO NOT WRITE IN THIS MARGIN

4. (continued)

(c) Complete the truth table for the logic circuit shown below.   **3**
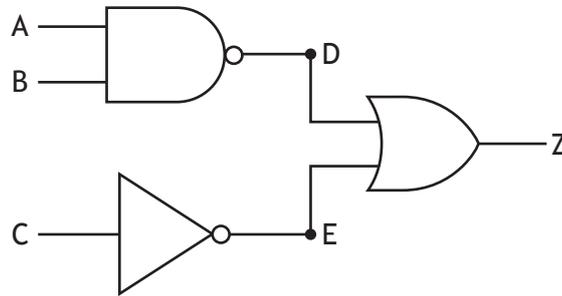
A	B	C	D	E	Z
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

(An additional truth table, if required, can be found on *page 16*.)

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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
Bipolar transistor		electronic switch
Cell		
		measures voltage across a circuit
Lamp		converts electrical energy into light energy
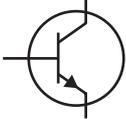
MARKS | DO NOT WRITE IN THIS MARGIN

1. **(continued)**

(b) A pupil selects a resistor with the colour coding as shown below.
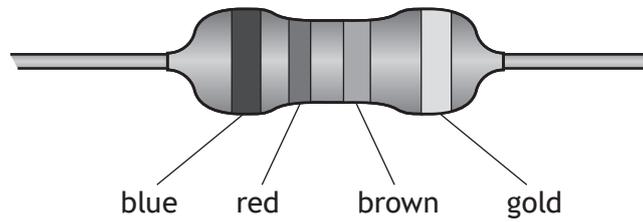
blue   red   brown   gold

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

(i) Determine the resistance of the resistor. **1**

(ii) State the percentage tolerance of this resistor. **1**

(iii) Determine the maximum and minimum resistance of this resistor in ohms. **2**

[Turn over

Marking instruction for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Supplies electrical (potential) energy/charge **(1 mark)**	3	Do not accept: - Supplies power Power supply Stores power Also accept: - Converts chemical energy to electrical
			voltmeter **(1 mark)** **(1 mark)**		Do not accept old bulb symbol
	(b)	(i)	620Ω **(1 mark)** **OR** 620R **OR** 0.62kΩ	1	If given in ohms must have unit, otherwise 0 marks. Also accept scientific notation with unit. 6.2×10^2 Ω
		(ii)	(±)5(%)	1	Accept answer without tolerance and/or percentage. Do not accept + or – on its own.
		(iii)	(Maximum) = 651Ω OR 651R **(1 mark)** (Minimum) = 589Ω OR 589R **(1 mark)**	2	Accept answer consistent with 1(b)(i) & (ii). Accept in any order. Accept value only. If maximum and minimum is incorrectly labelled award 0 marks.
2.			Any value greater than 10.0kΩ and less than 30.0kΩ **(1 mark)**	1	Accept a value only. Award correct mark if answer is out with table but must have correct unit.

2. The table below shows information about the resistance of a thermistor at different temperatures.

Temperature (°C)	Resistance (kΩ)
20	50.0
40	30.0
60	
80	10.0

Complete the table above to predict the resistance of the thermistor at 60 °C.

MARKS 1

3. A circuit diagram is shown below.
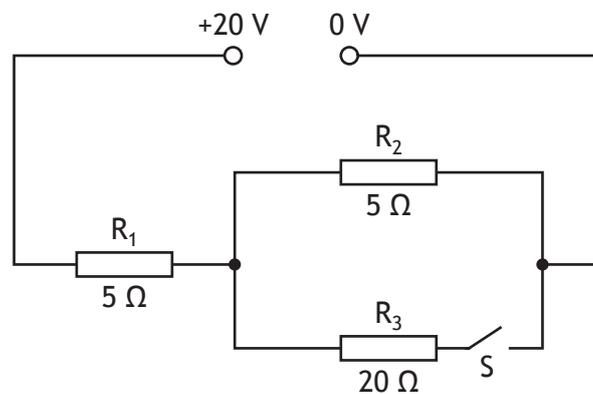
(a) Switch S is **open**.

(i) Calculate the total resistance of this circuit.

Space for working and answer

1

(ii) Calculate the current in this circuit.

Space for working and answer

3

Marking instruction for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Supplies electrical (potential) energy/charge **(1 mark)** voltmeter **(1 mark)** **(1 mark)**	3	Do not accept: - Supplies power Power supply Stores power Also accept: - Converts chemical energy to electrical Do not accept old bulb symbol
	(b)	(i)	620Ω **(1 mark)** **OR** 620R **OR** 0.62kΩ	1	If given in ohms must have unit, otherwise 0 marks. Also accept scientific notation with unit. 6.2×10^2 Ω
		(ii)	(±)5(%)	1	Accept answer without tolerance and/or percentage. Do not accept + or – on its own.
		(iii)	(Maximum) = 651Ω OR 651R **(1 mark)** (Minimum) = 589Ω OR 589R **(1 mark)**	2	Accept answer consistent with 1(b)(i) & (ii). Accept in any order. Accept value only. If maximum and minimum is incorrectly labelled award 0 marks.
2.			Any value greater than 10.0kΩ and less than 30.0kΩ **(1 mark)**	1	Accept a value only. Award correct mark if answer is out with table but must have correct unit.

MARKS | DO NOT WRITE IN THIS MARGIN

3. (a) (continued)

(iii) Calculate the power dissipated in resistor R_1. **3**

Space for working and answer

(b) Switch S is now **closed**.

(i) Calculate the effective resistance of R_2 and R_3 in parallel. **3**

Space for working and answer

(ii) Calculate the overall circuit resistance. **1**

Space for working and answer

[Turn over

Question			Expected response		Max mark	Additional guidance
3.	(a)	(i)	$(R_T = 5 + 5)$ $R_T = 10\ \Omega$	**(1 mark)**	1	Accept 10R Must have correct unit.
		(ii)	$V = IR$ $20 = I \times 10$ $I = 2\ A$	**(1 mark)** **(1 mark)** **(1 mark)**	3	Accept answer consistent with 3(a)(i) 1 mark for both relationships. 1 mark for substitutions. 1 mark for final answer including unit. Also accept alternative methods. Do not accept the term "Amps" as units.
		(iii)	$P = I^2 R$ $P = \cdot 2^2 \times 5$ $P = 20W$	**(1 mark)** **(1 mark)** **(1 mark)**	3	Accept answer consistent with 3(a)(ii) 1 mark for relationship. 1 mark for substitutions. 1 mark for final answer including unit. Also accept alternative formulas but with correct substitution.
	(b)	(i)	$\dfrac{1}{R_T} = \dfrac{1}{R_2} + \dfrac{1}{R_3}$ $\dfrac{1}{R_T} = \dfrac{1}{5} + \dfrac{1}{20}$ $R_T = 4\Omega$	**(1 mark)** **(1 mark)** **(1 mark)**	3	$R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ Is an acceptable alternative method. If wrong equation used, eg, $R_T = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ then (0) marks. Accept imprecise working towards a final answer. $\dfrac{1}{R_T} = 4\Omega$ accept Accept = 4 R Accept any subscript on component resistors.

Question			Expected response	Max mark	Additional guidance
3.	(b)	(ii)	$(R_T = 5 + 4)$ **(1 mark)** $R_T = 9\ \Omega$	1	Accept answer consistent with 3(b)(i) Accept 9R Must have correct unit.

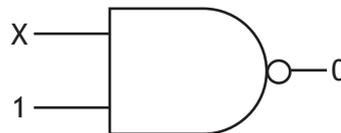**4.** There are many different types of logic gate used in electronics.

(a) Complete the truth table for an **NOR** gate.

1

A	B	Output
0	0	
0	1	
1	0	
1	1	

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

(b) A logic gate is shown below, with given logic states.

X ────┐
) ─o─ 0
1 ────┘

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

1

MARKS | DO NOT WRITE IN THIS MARGIN

4. **(continued)**

(c) Complete the truth table for the logic circuit shown below. **4**
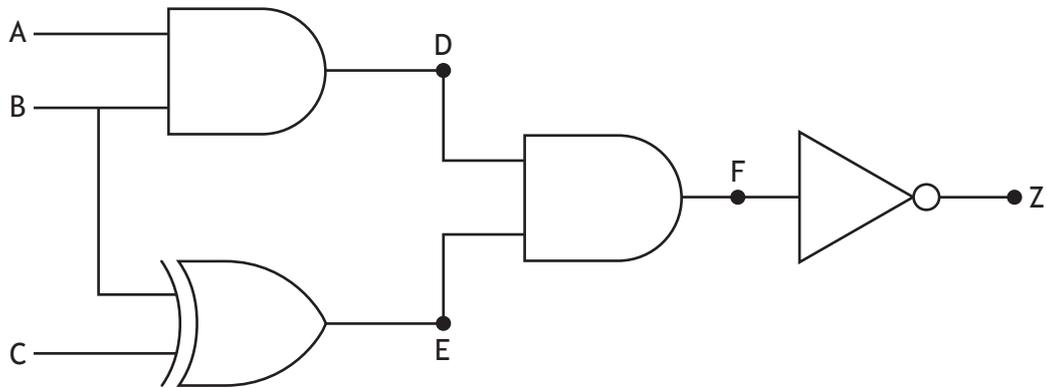
A	B	C	D	E	F	Z
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

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

[Turn over

	Question		Expected response							Max mark	Additional guidance

4. (a)

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

Max mark: **1**

(b) (Logic State) 1 **(1 mark)**

Max mark: **1**

Additional guidance: Accept 1, High, ON

(c)

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

Max mark: **4**

Additional guidance: 1 mark per column.

Apply follow through between columns.

MARKS | DO NOT WRITE IN THIS MARGIN

5. A student produces a simulation of a circuit that will turn on an LED when it gets too cold in a greenhouse.

However, the simulation does not work as specified.

Identify **four** errors in the student's simulation shown below.   4
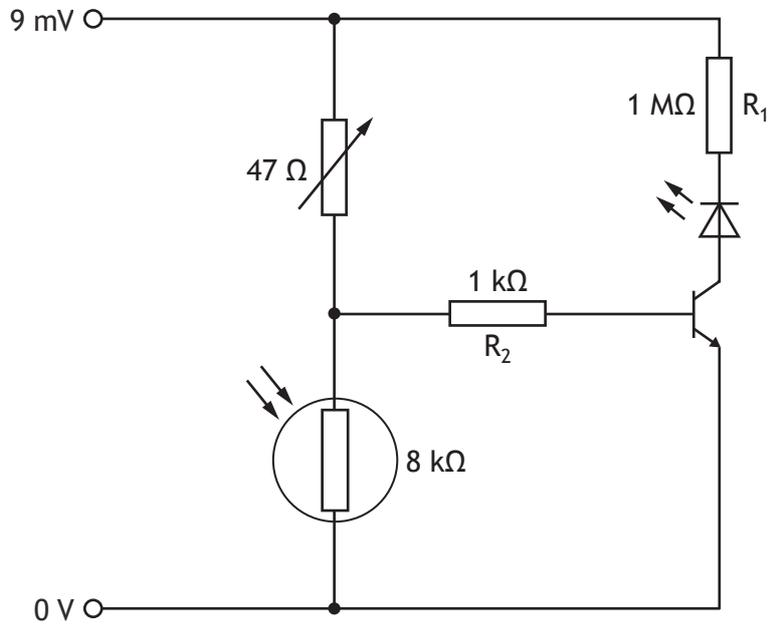
Error 1:

Error 2:

Error 3:
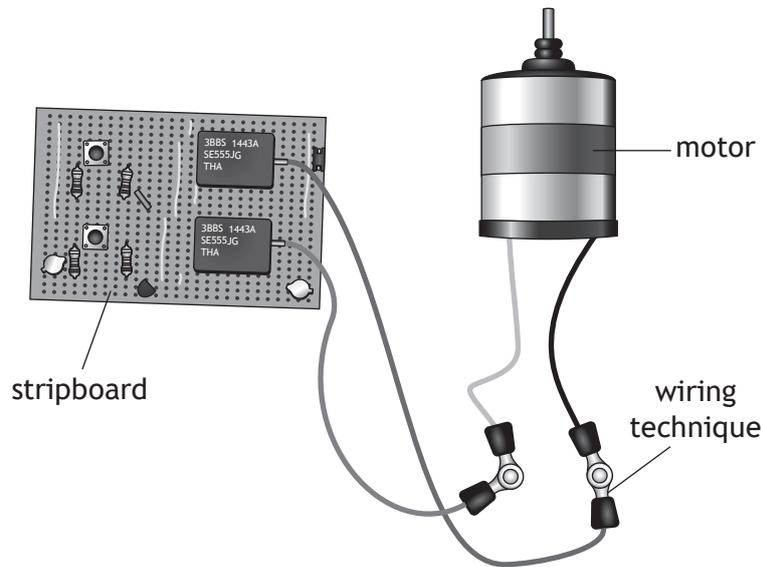
Error 4:

6. The image below shows the wiring connections between a stripboard and a motor for a circuit.

The wiring technique used in the photo is crimping.
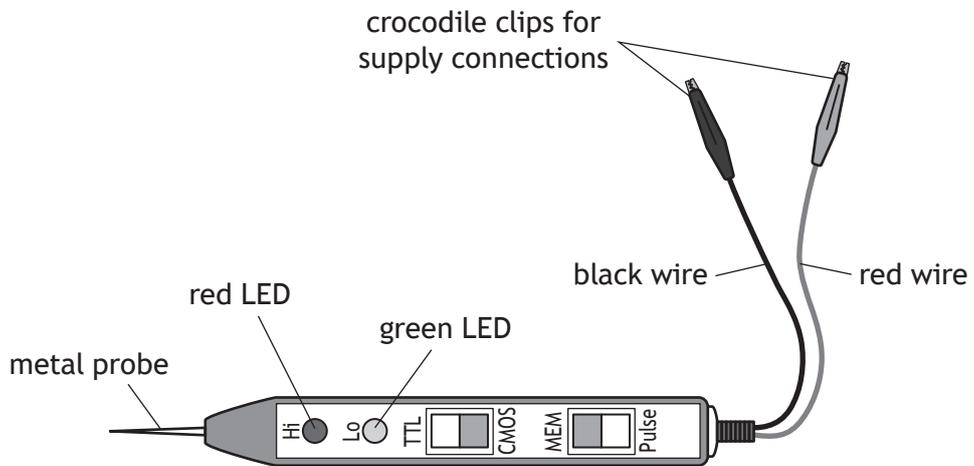
(a) State another wiring technique that could have been used to secure the wires together.　　**1**

(b) State one method that could be used to identify the correct wiring between the stripboard and motor.　　**1**

[Turn over

Question			Expected response	Max mark	Additional guidance
5.			Any four from • voltage supply value too small. • LED orientation/polarity wrong way round. • protective resistor (R_1) for LED has too high a resistance value. • incorrect component symbol used to measure temperature (Thermistor not LDR).	**4**	Errors can be listed in any order. Do not accept resistor too big/large.
6.	(a)		Connector blocks **(1 mark)** **OR** Terminal blocks	**1**	Do not accept the following: Cable ties, heat shrink, velcro straps, spiral wrap or connector on its own. Accept Solder **and** heat shrink. Accept screw terminal.
	(b)		Colour coding **(1 mark)** **OR** Wire/cable numbering	**1**	Any other suitable response.

MARKS

DO NOT WRITE IN THIS MARGIN

7. A logic probe, shown below, is used to test the inputs and outputs of a 74 series logic chip.

The logic probe is set to TTL and pulse.

crocodile clips for
supply connections

black wire — — red wire

red LED

green LED

metal probe

Hi Lo TTL CMOS MEM Pulse

(a) (i) State where the red and black wires should be connected. **1**

(ii) Describe how a logic 1 would be detected. **2**

X8607502 10

page 10

7. **(continued)**

(b) A student sets up a circuit on stripboard as shown below. IC_1 is a 74 series logic chip.
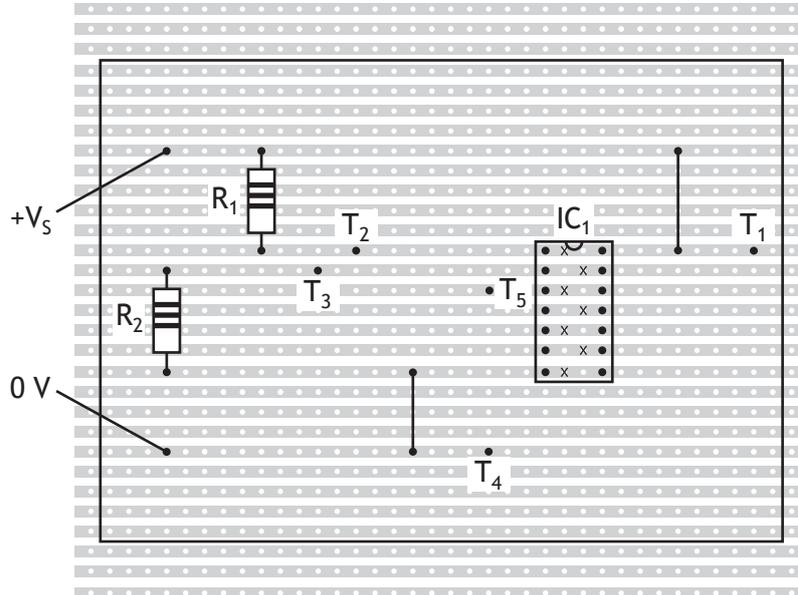
Test points T_1 to T_5 are marked on the stripboard.

(i) Identify two test points that are used to measure the voltage across R_2.　　**1**

(ii) The logic probe is placed at pin 7 of the logic chip, IC_1.

Explain why the LED on the logic probe flashes green.　　**1**

[Turn over

8. 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 shown below.
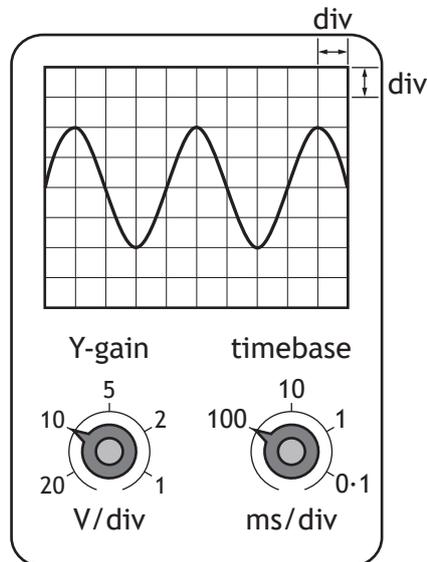
(a) Determine the peak voltage of this signal. **1**

(b) Calculate the frequency of the signal. **3**

Space for working and answer

|	Question		Expected response	Max mark	Additional guidance
7.	(a)	(i)	Connect red wire of probe to +V$_{supply}$ and black wire to 0v or equivalent. **(1 mark)**	1	Do not accept: connect the probe to the supply rails (on its own). Accept alternatives to V$_{supply}$, +V$_S$, +9V
		(ii)	Place the probe tip onto circuit at selected point. **(1 mark)** Red LED lights. **(1 mark)**	2	Independent marks.
	(b)	(i)	T3 and T4 **(1 mark)**	1	Answer must state test point numbers.
		(ii)	Pin 7 is connected to 0v **(1 mark)** or ground.	1	Accept: negative terminal (of the supply). Do not accept, "connected to the power supply" as it does not state high or low potential. Do not accept, "connected directly to the power supply". Do not accept "PIN 7 is logic 0 or negative" on its own.
8.	(a)		20 V **(1 mark)**	1	Must include unit.
	(b)		$T = (4 \times 100 \text{ ms}) = 400$ ms or 0.4s **(1 mark)** $f = \dfrac{1}{T}$ **(1 mark)** $f = 2.5$ Hz **(1 mark)**	3	If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula. If period incorrect then award a maximum of 1 mark for the formula. 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. Do not accept the term "Secs" as unit for seconds.

9. An LDR is used as a light sensor in a circuit to monitor and control the automatic mode setting of a car's headlights. Part of the circuit is shown below.
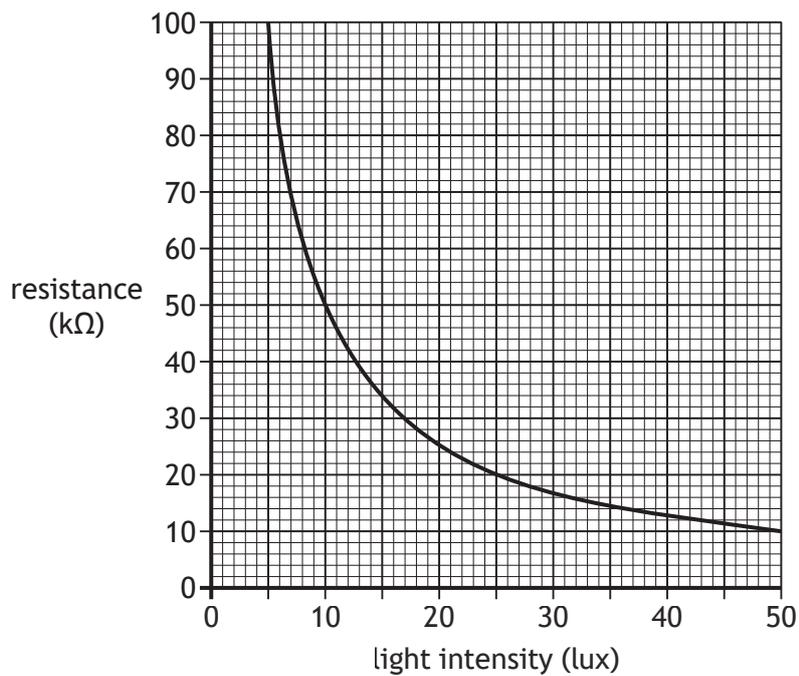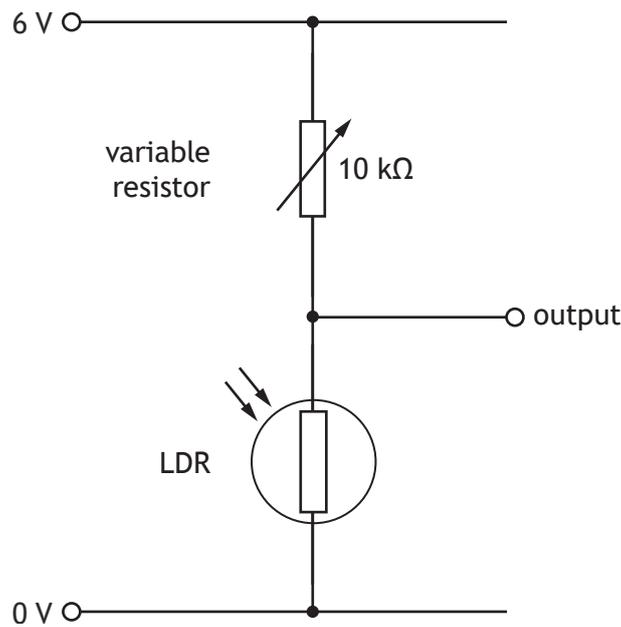
(a) (i) The graph above shows how the resistance of the LDR varies with the light intensity, measured in lux.

Use the graph to determine the resistance of the LDR when the light intensity is 25 lux.

MARKS 1

9. (a) (continued)
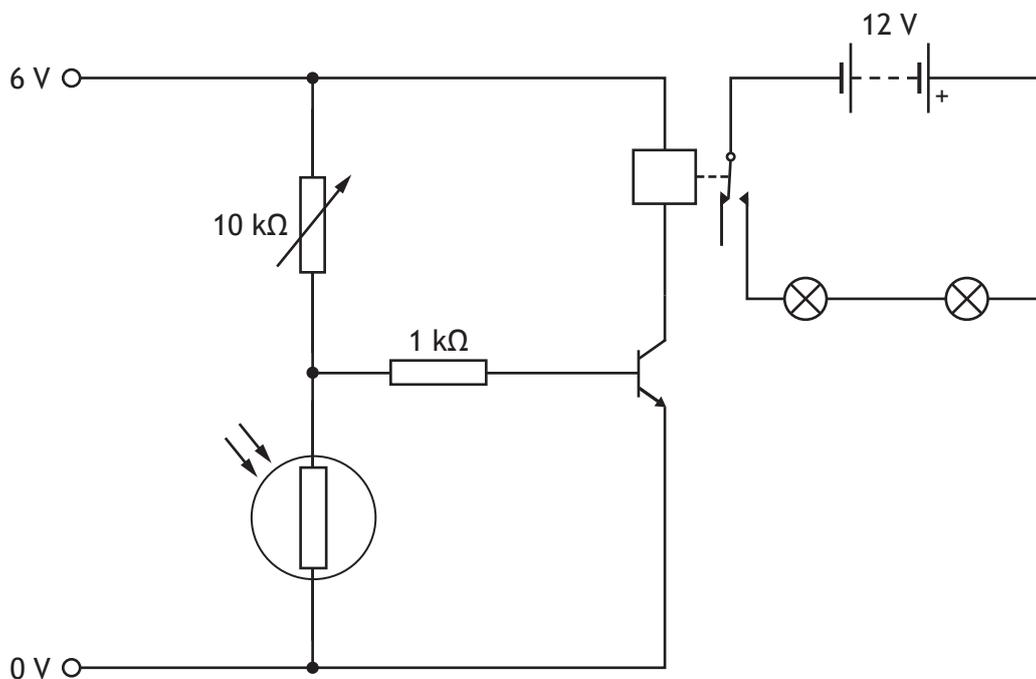
(ii) The variable resistor is now set at a resistance of 10 kΩ.

Calculate the voltage across the LDR when the light intensity is kept at 25 lux.

Space for working and answer

MARKS 3

(b) The potential divider is now connected to a switching circuit via the car battery to operate the car lights, as shown below.

(i) Explain how the circuit operates in order to switch on the car lights when the light intensity falls below a certain value.

3

MARKS | DO NOT WRITE IN THIS MARGIN

9. **(b)** **(continued)**

(ii) The operation of the circuit can be improved by the addition of one component connected in parallel with the relay.
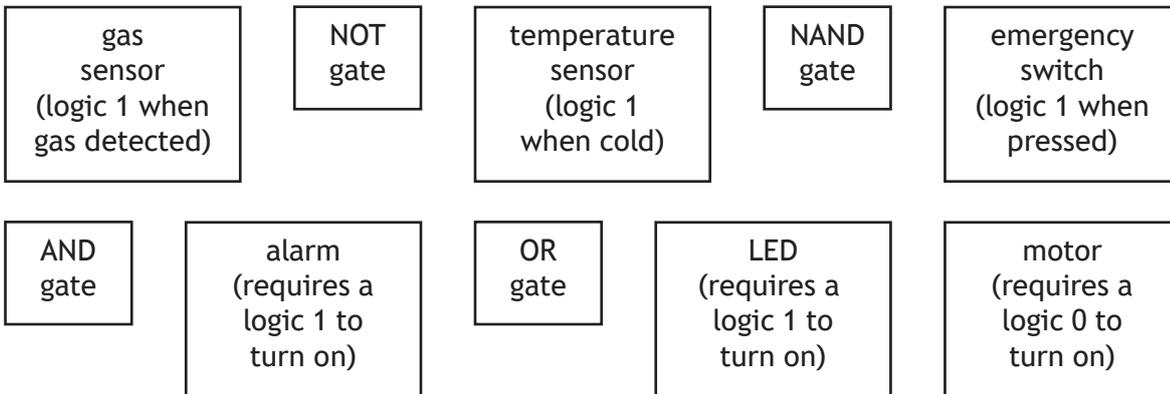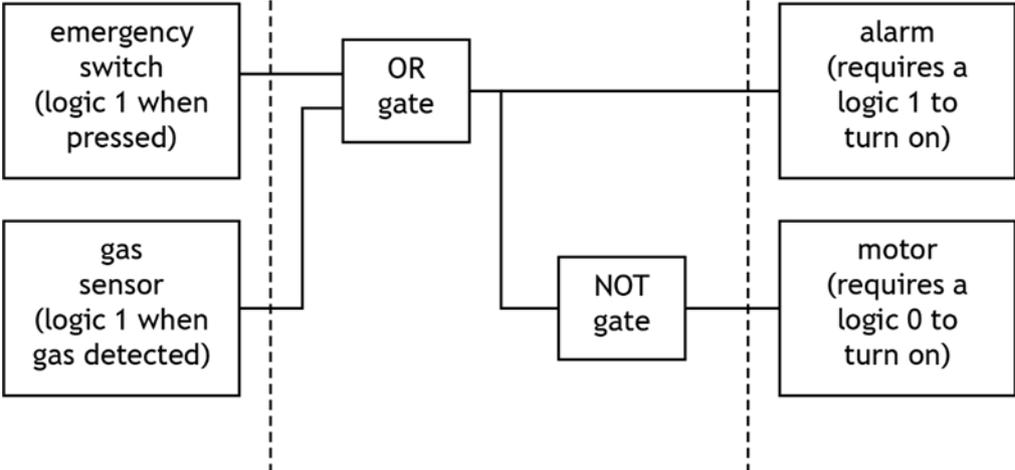
Name this component.　　　　　　　　　　　　　　**1**

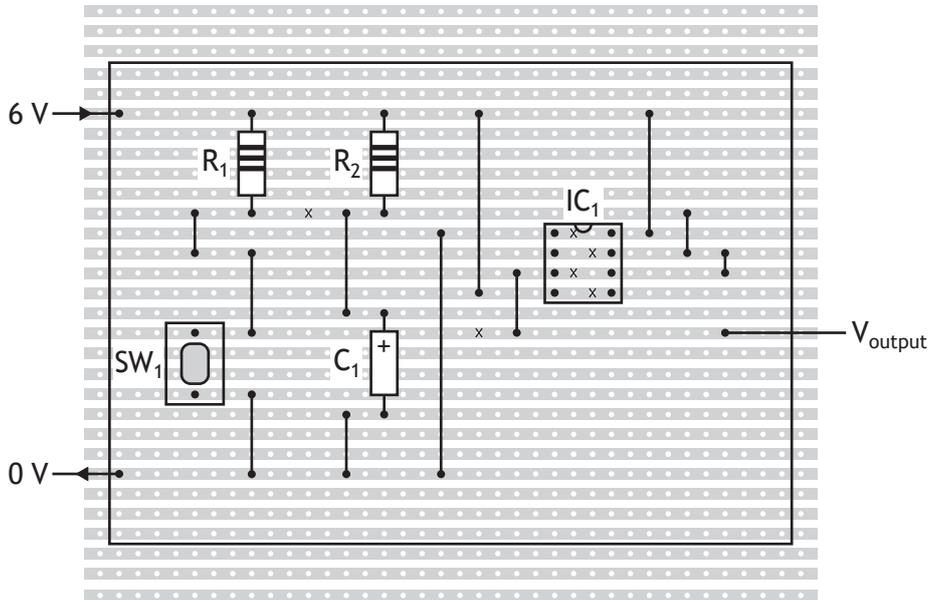| Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	20kΩ **(1 mark)** **OR** 20000Ω **OR** 20K	1	Must have unit or be in R notation. Allow a tolerance of + or – half a box.
		(ii)	$V_2 = \dfrac{R_2}{R_1 + R_2} \times V_S$ **(1 mark)** $V_2 = \dfrac{20}{(20+10)} \times 6$ **(1 mark)** $V_2 = 4V$ **(1 mark)**	3	Accept (20/30) × 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. $V_2/V_s = R_2/R_{total}$ $V_2/6 = 20/30$ $V_2 = 4V$ If correct answer with unit and no working award 3 marks. Accept follow through rule from Q9 a(i).
	(b)	(i)	LDR resistance increases and voltage across it increases. **(1 mark)** Transistor switches on at a certain voltage/0.7v **(1 mark)** Relay activates/turns on/closes **(1 mark)**	3	Independent marks Accept Transistor switches on/switch on voltage at 0.7v Answer must include the following three key points: - • LDR resistance increases • voltage increases to turn on Transistor at certain voltage • turns on RELAY (external circuit switches on) If transistor switching voltage is given as 2v award a maximum of 2 marks.
		(ii)	Diode **(1 mark)**	1	Do not accept the circuit symbol, the name must be given.

MARKS

10. A gas pipeline mechanism is required to detect gas leaks.

When a leak is detected, the gas should be switched off by a motor.

The system must include a gas sensor to monitor for any leaks.

The gas can be switched off when either an engineer presses an emergency switch or when the gas sensor detects gas.

If the gas is switched off, an audible alert should also be sounded.

Selecting from the elements given below, 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

gas sensor (logic 1 when gas detected)	NOT gate	temperature sensor (logic 1 when cold)	NAND gate	emergency switch (logic 1 when pressed)
AND gate	alarm (requires a logic 1 to turn on)	OR gate	LED (requires a logic 1 to turn on)	motor (requires a logic 0 to turn on)

Question			Expected response	Max mark	Additional guidance
10.			**1 mark** for correctly identifying the three separate sections of the system. **1 mark** for selecting both input devices. **1 mark** for selecting correct gates. **1 mark** for selecting both outputs. **1 mark** for correctly linking the inputs to the gates. **1 mark** for correctly linking the outputs to the gates.	**6**	All selected elements must be shown as part of a system/block diagram. (Arrows are NOT required on the connections). Accept switch, alarm, motor and gas sensor as block descriptors. Max 5 marks if not block diagram. Do not accept logic gate symbols.

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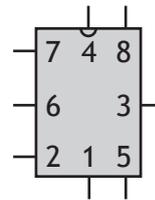

Component data

IC$_1$ — NE555

R$_1$ and R$_2$ — carbon film 10 KΩ 0.25 W
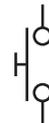
C$_1$ — 1000 µF 16 V **electrolytic** capacitor

SW$_1$ — push-to-make switch

X shows where a track has been cut.

Circuit symbol for IC$_1$

Circuit symbol for SW$_1$

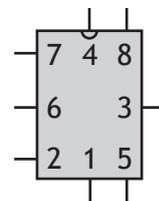MARKS | DO NOT WRITE IN THIS MARGIN

11. (continued)

For the stripboard layout diagram, complete the circuit diagram below.

Each component must be labelled.

6

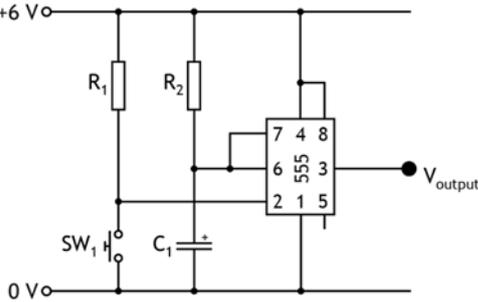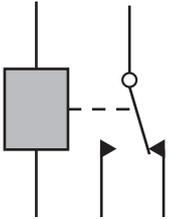(An additional circuit diagram template, if required, can be found on *page 21*.)

```
 7  4  8
 6     3
 2  1  5
```

[END OF QUESTION PAPER]

Question			Expected response	Max mark	Additional guidance
11.			Both power rails labelled with nodes. **(1 mark)**	6	 Accept IC1, 555 or NE555 for chip identifier.
			Power rails to IC. (4,8 to +6V and 1 to 0V) **(1 mark)**		
			SW$_1$ and R$_1$ in series between power rails, correctly positioned. **(1 mark)**		
			R$_2$ and C$_1$ in series between power rails with C$_1$ correctly orientated. **(1 mark)**		
			Pins 6, 7 and 2 connected, 5 not connected and correct connection of V$_{output}$ to pin 3 of 555 timer. Node must be included. **(1 mark)**		
			Each component must be identifiable and correctly used circuit symbols. (accept either values or identifiers). **(1 mark)**		

[END OF MARKING INSTRUCTIONS]

MARKS | DO NOT WRITE IN THIS MARGIN

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
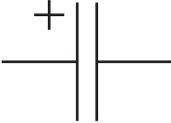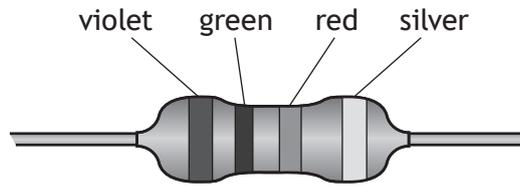
Component name	Symbol	Function
Electrolytic capacitor		stores charge
		electromagnetic switch
Diode		allows current to flow in one direction only
Thermistor		

MARKS | DO NOT WRITE IN THIS MARGIN
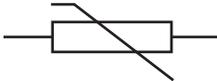
1. (continued)

(b) A technician selects a resistor with the colour coding as shown below.

violet   green   red   silver

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

(i) Determine the resistance of this resistor.　　　　　　　　　　　　**1**

(ii) State the percentage tolerance of this resistor.　　　　　　　　　**1**

(iii) Determine the maximum and minimum resistance of this resistor in **ohms.**　　　　　　　　　　**2**

Marking instruction for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Relay **(1 mark)** **(1 mark)** Changes resistance with (changes in) temperature **(1 mark)**	3	Do not accept switch Accept alternatives: Also accept - Must have input & output lines. Accept heat Accept expressions involving TURD (Temperature goes Up, Resistance goes Down)
	(b)	(i)	7.5 $k\Omega$ **OR** 7K5 **OR** 7500 Ω	1	If given in ohms must have unit. Also accept scientific notation with unit Accept 7500R Don not accept 7.5KR
		(ii)	($\pm$)10%	1	Accept answer without percentage If + or – is given on its own, do not award marks
		(iii)	Maximum = 8250 Ω **(1 mark)** Minimum = 6750 Ω **(1 mark)**	2	Accept answer consistent with 1(b)(i). Accept in any order. Accept without Max & Min name, but if given must be correct response. No penalty for omitting units, as "in ohms" is stated in the question.
2.			Any two from • Wear eye protection • Use stand • Use heat proof mat • Avoid breathing in fumes • Hold soldering iron correctly	2	Any acceptable alternate answer Do not accept "remove clothing" needs to justify why

MARKS

2. State **two** safety precautions that must be taken when using a soldering iron.   **2**

3. A circuit diagram is shown below.
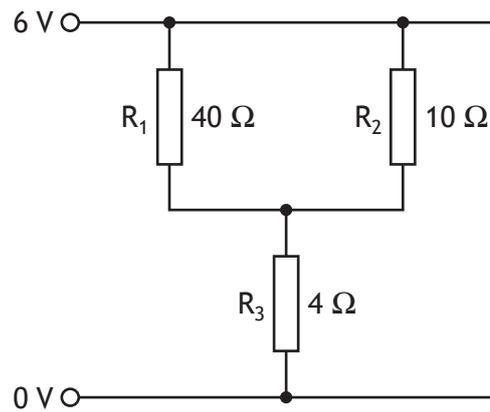
(a)   (i)   Calculate the effective resistance of R_1 and R_2 in parallel.   **3**

Space for working and answer

(ii)   Calculate the total resistance of this circuit.   **1**

Space for working and answer

MARKS

3. **(continued)**

(b) Calculate the current in resistor R_3. **3**

Space for working and answer

(c) Calculate the power dissipated in resistor R_3. **3**

Space for working and answer

[Turn over

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ (1 mark) $\dfrac{1}{R_T} = \dfrac{1}{40} + \dfrac{1}{10}$ (1 mark) $R_T = 8\,\Omega$ (1 mark)	3	$R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ Is an acceptable alternative method If wrong equation used, eg $R_T = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ then (0) marks Accept imprecise working towards a final answer $\dfrac{1}{R_T} = 8\,\Omega$ ↑ accept Accept = 8 R Accept any subscript on component resistors
		(ii)	$(R_T = 8 + 4)$ $R_T = 12\ \Omega$	1	Accept answer consistent with 3(a)(i) Accept 12R Must have correct unit
	(b)		$V = IR$ (1 mark) $6 = I \times 12$ (1 mark) $I = 0\cdot5\ A$ (1 mark)	3	Accept answer consistent with 3(a)(ii) 1 mark for both relationships 1 mark for substitutions 1 mark for final answer including unit Accept: $V_{R_3} = \left(\dfrac{R_3}{R_p + R_3}\right) V_s$ $V_{R_3} = \left(\dfrac{4}{8+4}\right) 6$ $= 2\ V$ And $V_{R_3} = I \times R_3 \quad 2 = I \times 4 \quad I = 2/4 = 0.5A$

Question			Expected response	Max mark	Additional guidance
3.	(c)		$P = I^2 R$ **(1 mark)** $P = 0\cdot5^2 \times 4$ **(1 mark)** $P = 1W$ **(1 mark)**	3	Accept answer consistent with 3(b) with correct substitutions 1 mark for both relationships 1 mark for substitutions 1 mark for final answer including unit Accept $V = I\,R_3$ $0.5 \times 4 = 2\ V$ $P = \dfrac{V^2}{R}$ $\qquad$ $P = IV$ $\qquad\qquad\quad$ $P = 0.5 \times 2$ $P = \dfrac{2^2}{4}$ $\qquad$ $P = 1W$ $P = 1W$

4. There are many different types of logic gate used in electronics.
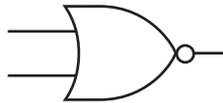
(a) Complete the truth table for an AND gate. **1**

A	B	Output
0	0	
0	1	
1	0	
1	1	

(An additional truth table, if required, can be found on *page 16*.)

(b) Name the logic gate shown below. **1**

	Question		Expected response						Max mark	Additional guidance

4. (a)

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

Max mark: **1**

(b) NOR (gate)

Max mark: **1**

(c)

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

Max mark: **3**

1 mark per column

Apply follow through between columns

5. Simulation is used in circuit design.

MARKS

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

2

(b) A student simulated the flashing LED circuit shown below.
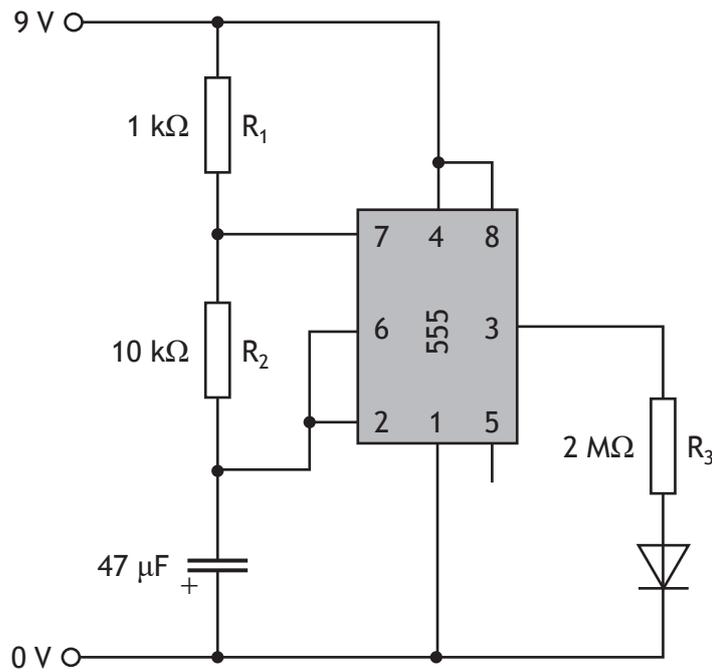
Identify **three** errors in the student's circuit.

3

Error 1:

Error 2:

Error 3:

6. A technician constructed a circuit from the schematic diagram shown below.

Complete the following table by giving **three** pre-power up checks for this circuit. **3**

Pre-power up checklist
Correct power supply voltage

[Turn over

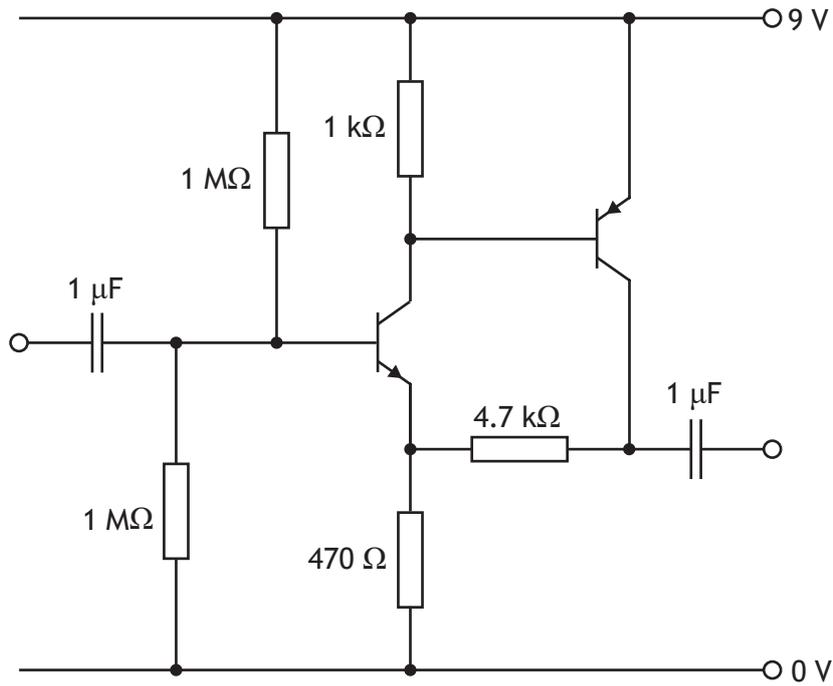| Question			Expected response	Max mark	Additional guidance
5.	**(a)**		Any two from • To establish if the circuit works • To improve the circuit design • Easily edited to try different combinations • Allows testing of sub-systems	**2**	Any other suitable response Do not accept: allows you to cost the circuit
	(b)		Orientation of (electrolytic) capacitor or (electrolytic) capacitor wrong way round **(1 mark)** Diode used, not LED **(1 mark)** (Protective resistor) R3 (for LED) has too high a resistance/value **(1 mark)**	**3**	Errors can be listed in any order Accept not using a LED rather than a diode Do not accept resistor too big/large Do not accept pin 5 is not connected/floating
6.			Any three from • Check that there is no short circuit across the circuit supply terminals • Power supply correct way round (0V lower rail) • Transistors in correct position or location • Ttransistor orientations correct • Resistor values • Capacitor values correct • Resistors in correct location • Capacitors in correct location • Check wiring is secure • Check for solder bridges	**3**	Any other suitable response

MARKS DO NOT WRITE IN THIS MARGIN

7. A student wants to check that the current flowing through a component is **1.2 mA DC**.
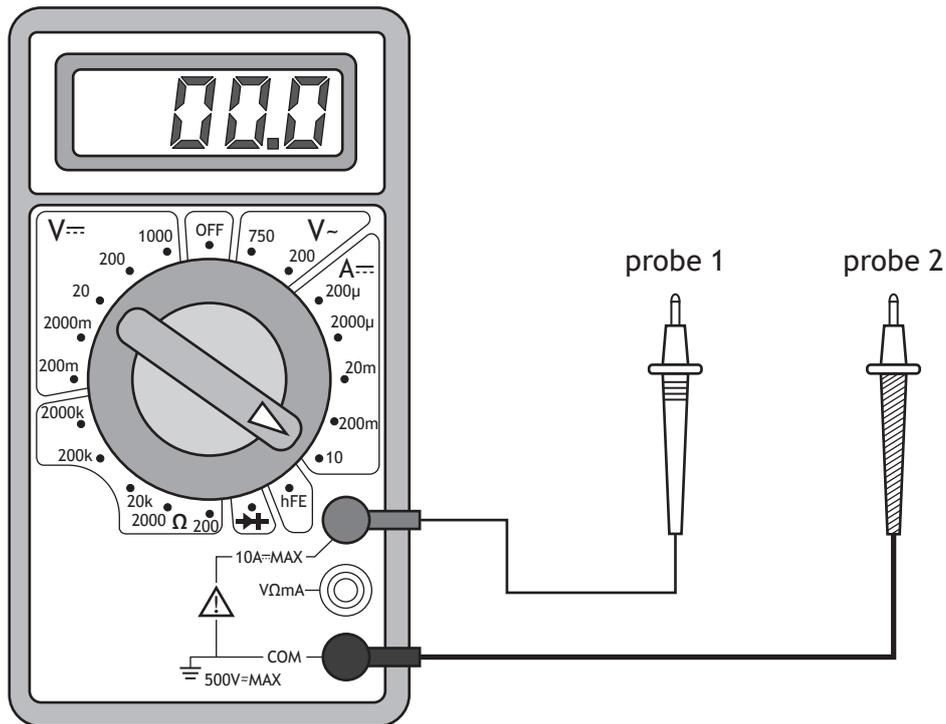
(a) Identify **two** changes that must be made to the multimeter to get the most accurate measurement. **2**

Change 1:

Change 2:

(b) Draw the symbol for direct current that is shown on the meter. **1**

(c) State the most appropriate scale that should be used to check the resistance of a 15 000 Ω resistor. **1**

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

MARKS

The trace is shown on the screen.

The Y-gain and timebase settings are also shown below.
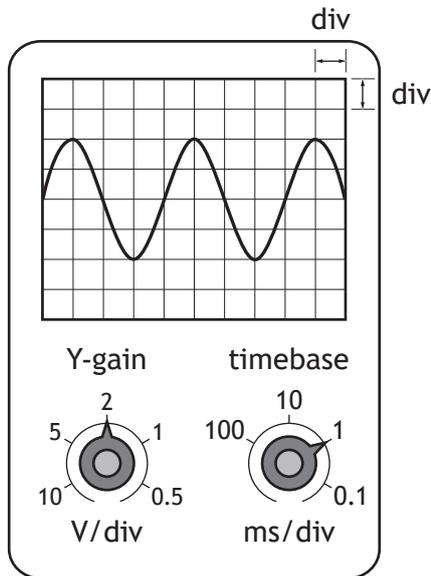
(a) State whether this signal is analogue or digital. **1**

(b) Determine the peak voltage of this signal. **1**

(c) Calculate the frequency of this signal. **3**

Space for working and answer

| Question			Expected response	Max mark	Additional guidance
7.	(a)		Connect probe 1 to the VΩmA or middle socket of multimeter **(1 mark)** Select 2000 μ range **(1 mark)**	2	Probe must be identified as probe 1 Accept Red instead of Probe 1 Accept range/scale as interchangeable
	(b)		▬▬▬ ▬ ▬ ▬	1	Also accept A and symbol but do not accept V and symbol.
	(c)		$20K$	1	Accept 20,000 no unit required
8.	(a)		Analogue (signal)	1	
	(b)		$4\ V$	1	Must include unit.
	(c)		$T = (4 \times 1\ ms) = 4\ ms$ or $4 \times 10^{-3}\ s$ or $0.004s$ **(1 mark)** $f = \dfrac{1}{T}$ **(1 mark)** $f = 250\ Hz$ **(1 mark)**	3	If incorrect setting chosen from oscilloscope award a maximum of 1 mark for the formula If period incorrect then award a maximum of 1 mark for the formula 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 $0\cdot25\ kHz$, in which case 3 marks may be awarded Accept f=N/t

9. A child's LED night light is controlled using a LM741 comparator circuit as shown below.
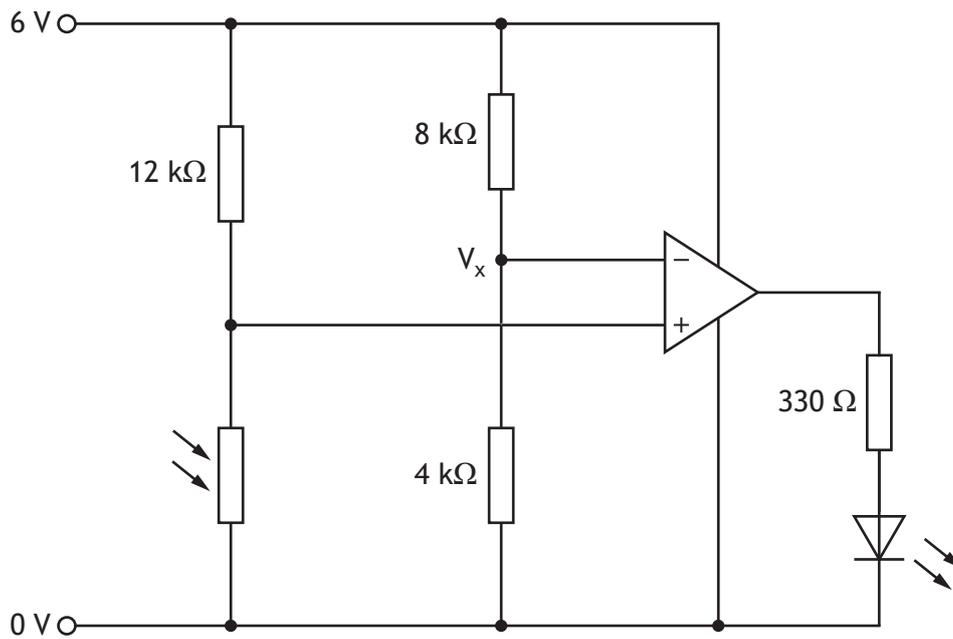
(a) Calculate the reference voltage V_x.

Space for working and answer

3

(b) State the resistance of the light dependent resistor when the voltage across it is equal to the reference voltage V_x.
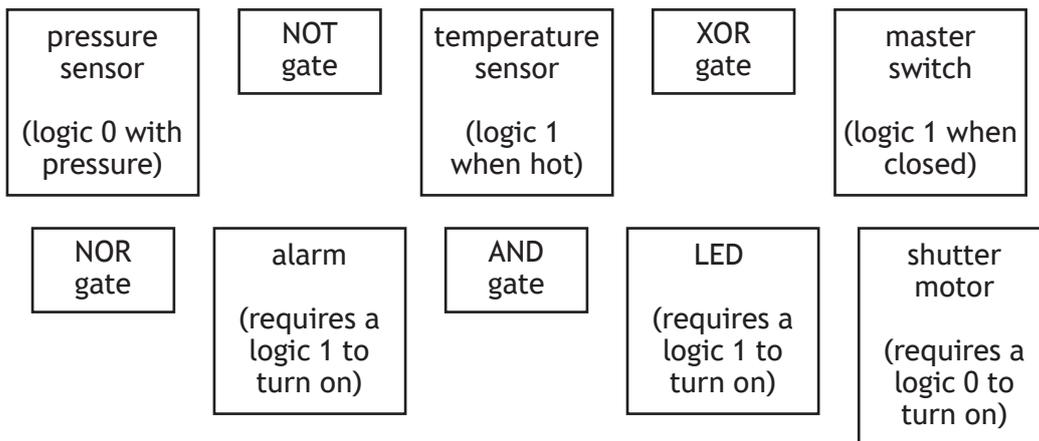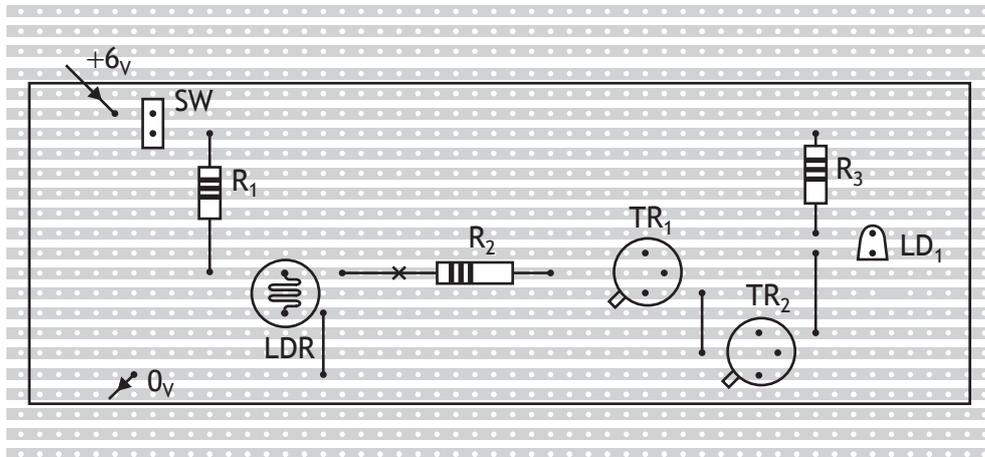
1

(c) Describe how this circuit works.

3

Question			Expected response	Max mark	Additional guidance
9.	(a)		$V_x = \dfrac{R_2}{R_1 + R_2} \times V_S$ **(1 mark)** $V_x = \dfrac{4000}{(8000 + 4000)} \times 6$ **(1 mark)** $V_x = 2V$ **(1 mark)**	3	Accept (4/12) × 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 $V_x / V_s = R_2 / R_{total}$ $V_x / 6 = 4000 / 12000$ $V_x = 2V$ If correct answer with unit and no working award 3 marks
	(b)		6 $k\Omega$ **OR** 6000 Ω **OR** $6K$	1	Must have unit or be in R notation Accept answer consistent with Vx calculated in 9(a)
	(c)		As light level reduces LDR resistance increases **(1 mark)** As LDR resistance increases the voltage across LDR increases **(1 mark)** When voltage across the LDR = V_x then LM741/comparator/IC/op amp output switches on, powering the LED **(1 mark)**	3	Accept V ref = V_x = trigger voltage = switch on voltage Accept marks independently Accept LED lights up Accept alternatives to = Do not accept arrow symbols as alternatives to increase and decrease

10. A security system for an art gallery is required to protect an expensive vase.

The system must include a sensor that can detect if the vase has been lifted.

When the vase is lifted, this will turn on an alarm and a motor which closes the shutter on the gallery door.

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

Selecting from the elements given below, 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

pressure sensor (logic 0 with pressure)	NOT gate	temperature sensor (logic 1 when hot)	XOR gate	master switch (logic 1 when closed)
NOR gate	alarm (requires a logic 1 to turn on)	AND gate	LED (requires a logic 1 to turn on)	shutter motor (requires a logic 0 to turn on)

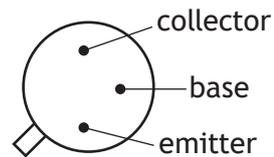| Question	Expected response	Max mark	Additional guidance
10.	**1 mark** for selecting both input devices **1 mark** for selecting correct gates **1 mark** for selecting both outputs **1 mark** for correctly linking the inputs and gates **1 mark** for linking **both** AND gate and NOT gate to outputs **1 mark** for correctly identifying the three sections of the system	6	All selected elements must be shown as part of a system/block diagram (arrows are NOT required on the connections) Accept switch, alarm, motor and pressure sensor as block descriptors Accept solid sepreation lines Do not accept a list/table of elements

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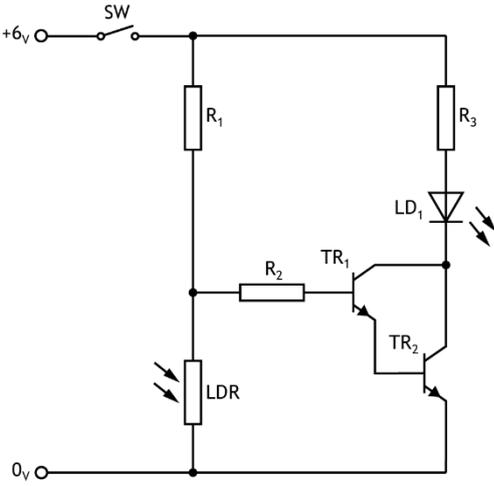

Component data

TR$_1$ and TR$_2$ — BFY51 npn transistors

LD$_1$ — 5 mm standard led (red)

LDR — ORP12 light dependent resistor

R$_1$ — carbon film 10 K 0.25 w

R$_2$ — carbon film 6K8 0.25 w

R$_3$ — carbon film 270 R 0.25 w

SW — SPST switch (on/off switch)

TR$_1$ and TR$_2$ pin connections

collector

base

emitter

Draw a circuit diagram for this circuit.

Each component must be labelled.

6

Question	Expected response	Max mark	Additional guidance
11.	Both power rails labelled with nodes **(1 mark)** Switch in correct position **(1 mark)** R_1, LDR voltage divider to R_2 **(1 mark)** Transistor positions/connections in relation to each other and 0v rail. **(1 mark)** Collectors to + 6V via 270R resistor and LED in series with correct orientation. **(1 mark)** Component labelling (either values or identifiers) **(1 mark)**	6	 Any errors in circuit symbols max 5 marks, only if candidate has achieved maximum marks for the question Accept LED$_1$ as the label Accept SPST as a descriptor for SW

[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.

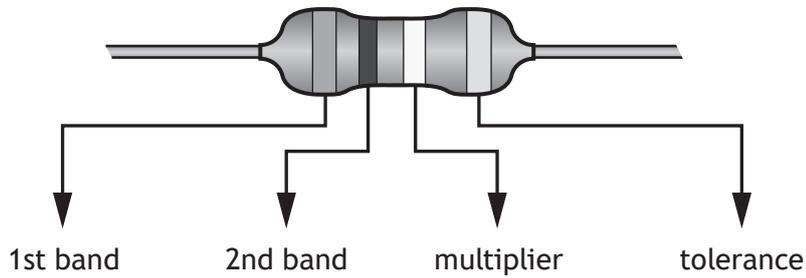   (a) Complete the table for the missing entries. **3**
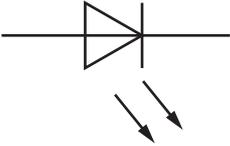
Component name	Symbol	Function
Light emitting diode		Emits light indicating a current flow
Speaker		
		Stores charge
Variable resistor		A resistor whose resistance value can be adjusted
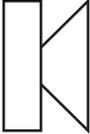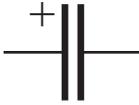
1. **(continued)**

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

| 1st band | 2nd band | multiplier | tolerance |

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

Determine the colour codes for a resistor of value 4K7 with a ±1% tolerance.

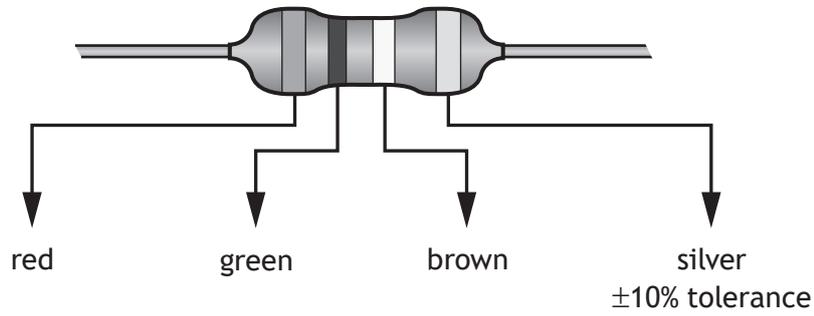**2**

	1st band	2nd band	Multiplier	Tolerance
Colour code				brown

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

1. **(continued)**

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

red   green   brown   silver
±10% tolerance

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

(i) Determine the resistance of the second resistor.

Space for working and answer

1

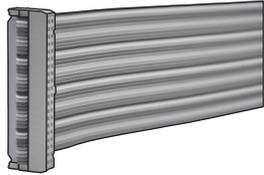(ii) Determine the minimum and maximum resistance of the second resistor.

Space for working and answer

2

MARKS |

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

	Cable type	Typical use
	fibre optic	
	ribbon cable	

[Turn over

Marking instruction for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		Changes electrical energy to sound (energy) **(1 mark)** Electrolytic capacitor **(1 mark)** **(1 mark)**	3	Do not accept changes **electricity** to sound Must state electrolytic
	(b)		<table><tr><td>1st band</td><td>2nd band</td><td>multiplier</td></tr><tr><td>yellow</td><td>violet</td><td>red</td></tr></table>	2	1 mark for both colour bands 1 mark for multiplier colour band
	(c)	(i)	250 Ω **OR** 250R	1	Answer must have ohms unit or R notation
		(ii)	Min = 225 Ω **OR** 225R **(1 mark)** Max = 275 Ω **OR** 275R **(1 mark)**	2	Accept answer consistent with 1(c)(i)
2.			Cable tv, telephone cabling, secure landline communications cabling, broadband **(1 mark)** Computer cabling, internal connections inside mobile phones Computer peripheral cabling **(1 mark)**	2	Any two suitable answers.
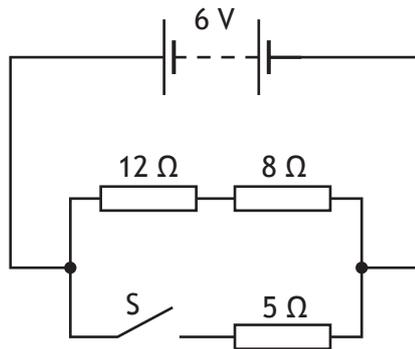
MARKS | DO NOT WRITE IN THIS MARGIN

3. A circuit diagram is shown below.

(a) Switch S is **open**.

   (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

MARKS

DO NOT WRITE IN THIS MARGIN

3. **(continued)**

(b) Switch S is now **closed**.

(i) Calculate the total resistance of the circuit.

Space for working and answer

3

(ii) State the voltage across the 5 Ω resistor.

1

(iii) Calculate the power dissipated in the 5 Ω resistor.

Space for working and answer

3

X860750107

MARKS | DO NOT WRITE IN THIS MARGIN

4. Logic gates are widely used in electronic circuits.

(a) Complete the truth table for a NAND gate.　　　　　　　**1**

A	B	Output
0	0	
0	1	
1	0	
1	1	

(An additional truth table, if required, can be found on *page 22*)

(b) A logic gate is shown below.
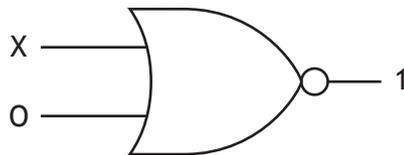
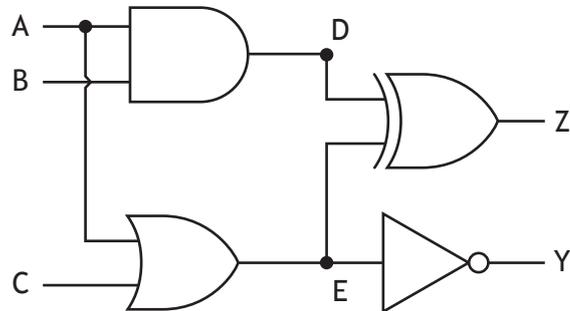Determine the logic state at X that would produce the output shown.　**1**

4. **(continued)**

(c) Many electronic devices use a combination of interconnected logic gates.

Complete the truth table for the logic circuit shown below. **4**

A	B	C	D	E	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 22*)

[Turn over

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	20 Ω **OR** 20 R	1	Answer must have ohms unit or R notation
		(ii)	$V = IR$ **(1 mark)** $6 = I \times 20$ **(1 mark)** $I = 0{\cdot}3\ A$ **(1 mark)**	3	Accept answer consistent with 3(a)(i)
	(b)	(i)	$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ **(1 mark)** $\dfrac{1}{R_T} = \dfrac{1}{20} + \dfrac{1}{5}$ **(1 mark)** $R_T = 4\Omega$ **(1 mark)**	3	$R_T = \dfrac{R_2 R_3}{R_2 + R_3}$ Is an acceptable alternative method If wrong equation used, eg $R_T = \dfrac{1}{R_2} + \dfrac{1}{R_3}$ then (0) marks. Accept imprecise working towards a final answer. $\dfrac{1}{R_T} = 4\Omega$ $\uparrow$ Accept Accept = 4 R Accept any subscript on component resistors
		(ii)	6V **(1 mark)**	1	Answer must have unit

Question			Expected response	Max mark	Additional guidance
		(iii)	$P = \dfrac{V^2}{R}$ **(1 mark)** $P = \dfrac{6^2}{5}$ **(1 mark)** $P = 7 \cdot 2 \text{ W}$ **(1 mark)**	3	Accept answer consistent with 3(b)(ii) Both equations 1 mark Both substitutions 1 mark Answer and unit 1 mark $V = IR$ $6 = I \times 5$ $I = 1 \cdot 2(A)$ $P = IV$ $P = 1 \cdot 2 \times 6$ $P = 7 \cdot 2W$ **OR** $P = I^2 R$ $R = 1 \cdot 2^2 \times 5$ $P = 7 \cdot 2W$
4.	(a)		<table><tr><td>**A**</td><td>**B**</td><td>**Output**</td></tr><tr><td>0</td><td>0</td><td>1</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>0</td></tr></table>	1	

Question			Expected response							Max mark	Additional guidance
	(b)		0							1	
	(c)		A	B	C	D	E	Y	Z	4	1 mark per column
			0	0	0	0	0	1	0		Apply follow through between columns
			0	0	1	0	1	0	1		
			0	1	0	0	0	1	0		
			0	1	1	0	1	0	1		
			1	0	0	0	1	0	1		
			1	0	1	0	1	0	1		
			1	1	0	1	1	0	0		
			1	1	1	1	1	0	0		

MARKS | DO NOT WRITE IN THIS MARGIN

5. A logic probe is used to test the inputs and outputs of a 7400 series logic chip.

The logic probe is set to TTL and pulse.
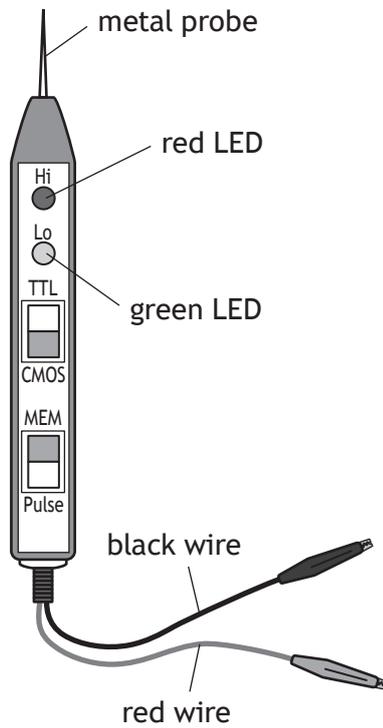
(a) State where the red and black wires should be connected.   1

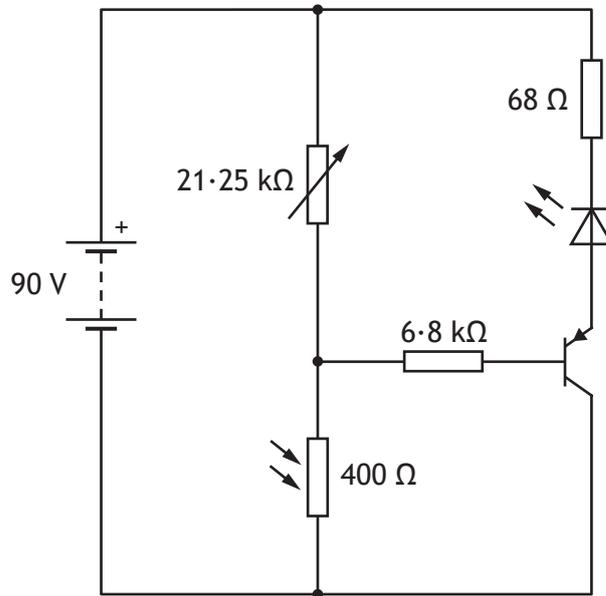(b) Describe how a logic **0** would be detected.   2

MARKS

DO NOT WRITE IN THIS MARGIN

6. A student produces a simulation of a circuit that will turn on a LED when it gets dark.

However, the simulation does not work as specified.

Identify four errors in the simulation below.
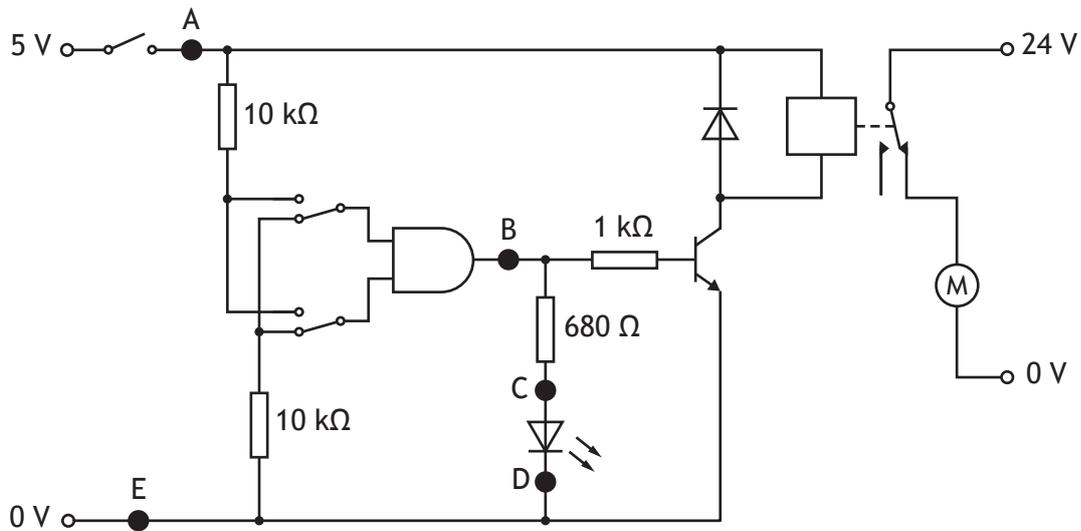
4

Error 1:

Error 2:

Error 3:

Error 4:

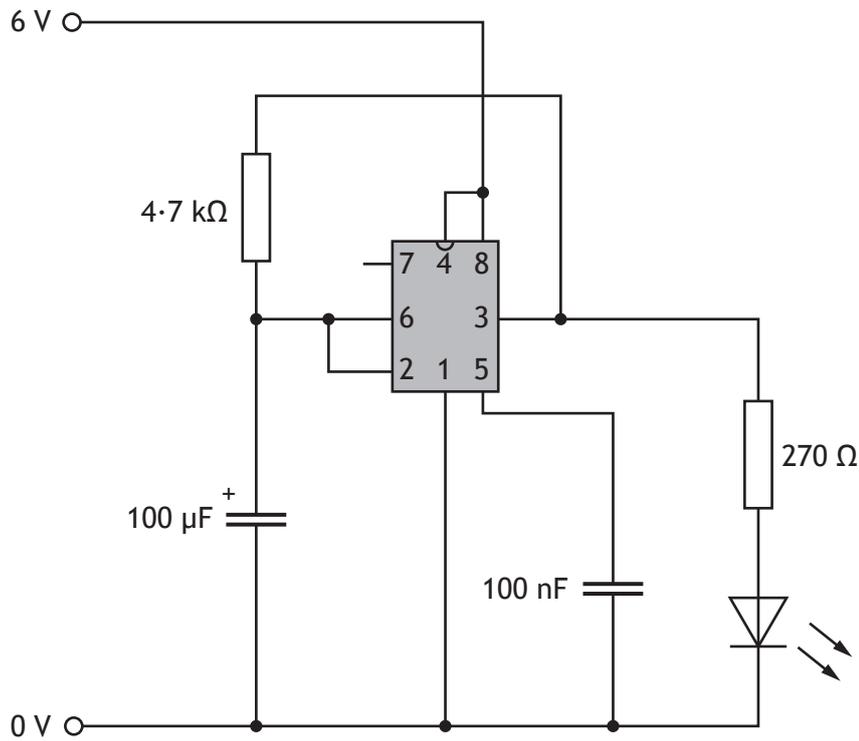7. The circuit diagram below has test points A, B, C, D and E as shown.

Complete the table below stating what the test points measure and the instrument used to carry out each test.

2

Test points	Measuring	Instrument
A and E	supply voltage	multimeter voltage setting
B		
C and D		

8. A student builds the circuit shown below.

Using the information from the two suppliers catalogues shown on the opposite page, complete the costings sheet below 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		
	100 µF electrolytic capacitor		
	100 nF capacitor		
	270R		
	4K7		

(An additional costings sheet, if required, can be found on *page 23*)

| Question			Expected response	Max mark	Additional guidance
5.	(a)		Connect red wire of probe to V$_{supply}$ and black wire to 0 V **(1 mark)**	1	Do not accept: connect the probe to the supply rails (on its own)
	(b)		Place the probe tip onto circuit at selected point **(1 mark)** Green LED lights **(1 mark)**	2	
6.			Supply voltage too high **(1 mark)** LED wrong way round **(1 mark)** Protective resistor for LED has too low a resistance **(1 mark)** Transistor should be a npn/mosfet **(1 mark)** **OR** LDR and variable resistor should be changed over position in circuit **(1 mark)**	4	Errors can be listed in any order
7.			<table><tr><td>Measuring</td><td>Instrument</td></tr><tr><td>supply voltage</td><td>multimeter voltage setting</td></tr><tr><td>Output logic level from gate</td><td>Logic probe</td></tr><tr><td>Voltage across LED</td><td>Multimeter voltage setting</td></tr></table>	2	1 mark for each row Accept logic level Accept voltmeter Do not accept multi-meter on its own
8.			<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>100µF electrolytic capacitor</td><td>EC 800</td><td>10</td></tr><tr><td>SWIFT</td><td>100nF capacitor</td><td>CP-2030</td><td>35</td></tr><tr><td>JIMSON</td><td>270R</td><td>FR 922</td><td>0·25</td></tr><tr><td>JIMSON</td><td>4K7</td><td>FR 923</td><td>0·25</td></tr></table>	5	1 mark for each row

8. (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
Capacitors	10 nF	16 V	CP-2020	30p
	100 nF	16 V	CP-2030	35p
	100 nF	5 V	CP-2040	40p
Electrolytic capacitors	10 µF	16 V	CP-0555	10p
	100 µF	16 V	CP-0566	18p
	100 µF	5 V	CP-0599	8p
Resistors	270R	0·25 W carbon film 5%	EC-0161	0·5p
	4K7	0·25 W carbon film 5%	EC-0175	0·5p
	47K	0·25 W carbon film 5%	EC-0182	1·5p
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
Capacitors	10 nF	16 V	CP 120	12p
	100 nF	16 V	CP 135	45p
	100 nF	5 V	CP 140	25p
Electrolytic capacitors	10 µF	16 V	EC 799	14p
	100 µF	16 V	EC 800	10p
	100 µF	5 V	EC 801	8p
Resistors	270R	0·25 W carbon film 5%	FR 922	0·25p
	4K7	0·25 W carbon film 5%	FR 923	0·25p
	47K	0·25 W carbon film 5%	FR 924	2p

MARKS | DO NOT WRITE IN THIS MARGIN

9. A technician needs to work in a well lit room. For safety reasons when the light level decreases to 250 lux an alarm sounds.

The alarm circuit uses a light dependent resistor as a sensor. The graph below shows how the resistance of the LDR varies with changing light levels.
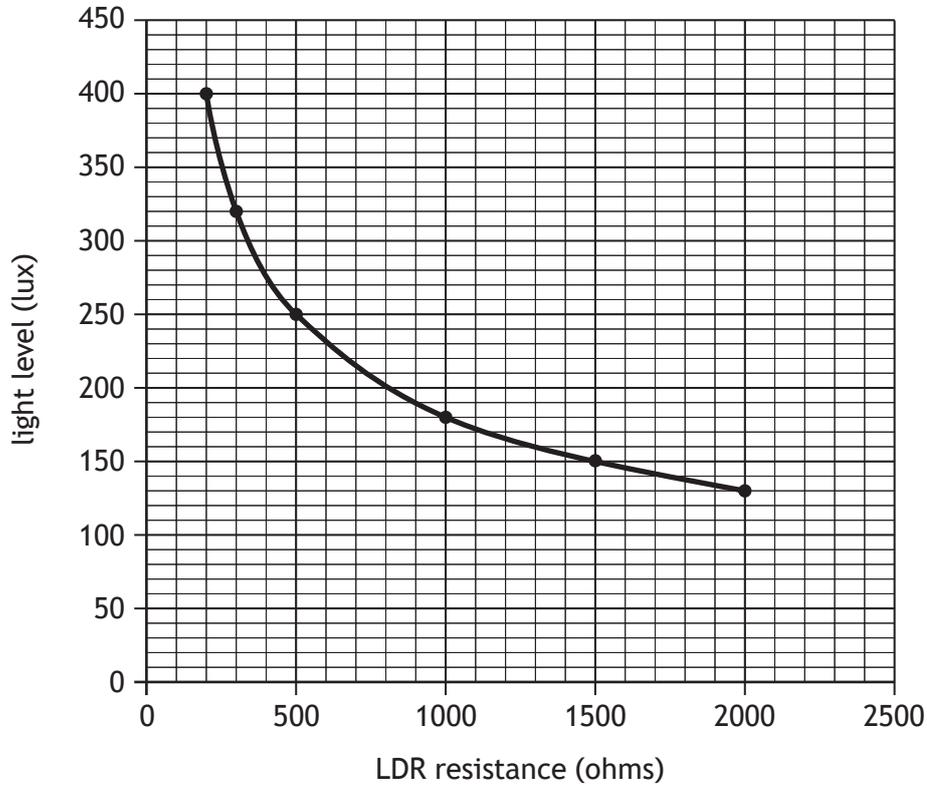
(a) State the resistance of the LDR when the alarm sounds. **1**
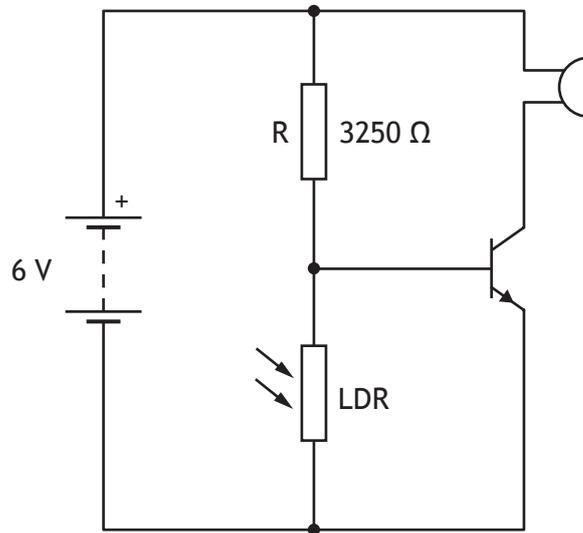
MARKS | DO NOT WRITE IN THIS MARGIN

9. **(continued)**

(b) The alarm circuit is shown below.

Calculate the voltage across the LDR when the alarm (buzzer) sounds. **3**

Space for working and answer

(c) Describe how this circuit works. **3**

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

[Turn over

Question			Expected response	Max mark	Additional guidance
9.	(a)		500 Ω **OR** 500R	**1**	
	(b)		$V_2 = \dfrac{R_2}{R_1 + R_2} \times V_S$ **(1 mark)** $V_2 = \dfrac{500}{(3250 + 500)} \times 6$ **(1 mark)** $V_2 = 0\cdot8V$ **(1 mark)**	**3**	Accept answer consistent with 9(a) $V = IR$ $6 = I \times 3750$ $I = 0.0016$ $I = 1\cdot6 \times I0^{-3}(A)$ $V = IR$ $V = 1\cdot6 \times I0^{-3} \times 500$ $V = 0\cdot8V$ 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.
	(c)		As light level reduces LDR resistance increases **(1 mark)** As LDR resistance increases the voltage across LDR increases. **(1 mark)** When voltage across the LDR reaches 0·8V transistor switches on **(1 mark)**	**3**	

MARKS | DO NOT WRITE IN THIS MARGIN

10. A zoo uses an incubator to keep eggs warm.

A safety system for the incubator requires an electric heater to turn on when the temperature in the incubator becomes too cold.

When the heater is turned on during daylight hours an alarm should sound.

Selecting from the elements given below, draw a **block diagram** of an electronic solution for this system.
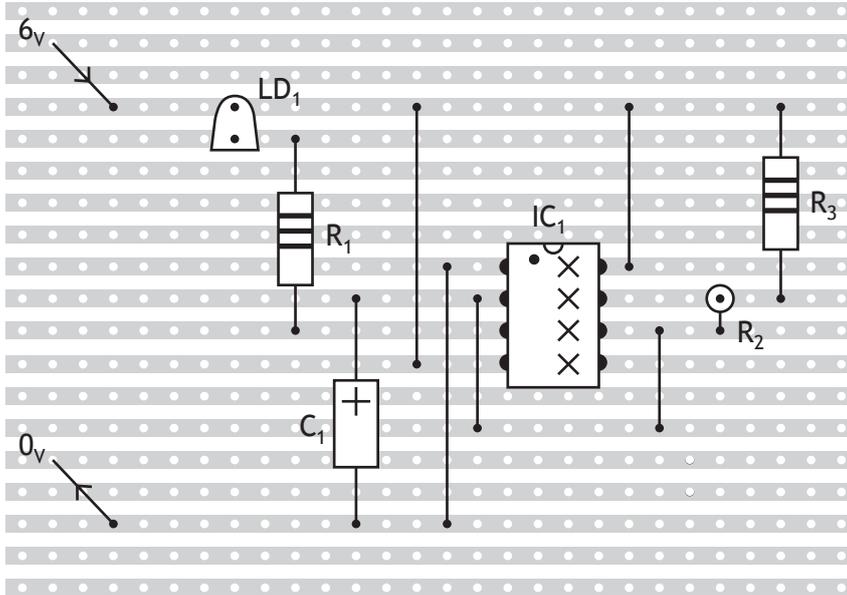
On your diagram, clearly indicate the input, process and output sections of your solution.

6

light sensor (logic 1 for light)	motion sensor (logic 1 for motion)	temperature sensor (logic 1 for hot)	buzzer	XOR gate	AND gate
			heating element	NOT gate	lamp

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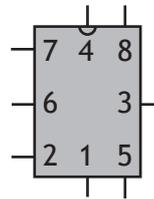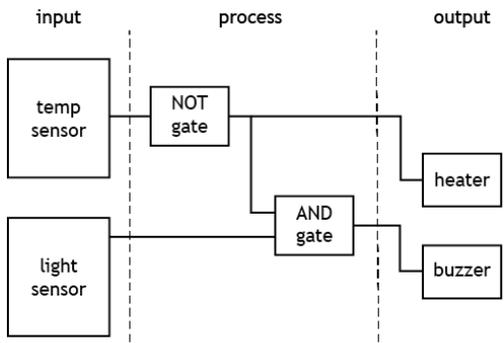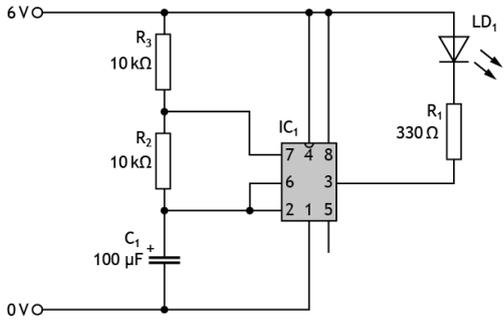

Note R_2 vertically mounted.

Component data

IC_1 — NE555

LD_1 — 5 mm standard led (red)

R_1 — carbon film 330 R 0·25 w

R_2 and R_3 — carbon film 10 K 0·25 w

C_1 — 100 µF 16 V **electrolytic** capacitor

Draw a circuit diagram for this circuit.

Each component must be labelled.

Circuit symbol for IC_1

MARKS

6

Question			Expected response	Max mark	Additional guidance
10.			**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 outputs to the gates **1 mark** for correctly identifying the three sections of the system	6	 All selected elements must be shown as part of a system/block diagram. (arrows are NOT required on the connections).
11.			Both power rails labelled with nodes **(1 mark)** Power rails to IC (4,8 to +6V and 1 to 0V) **(1 mark)** The "output" +6V to pin 3 via R_1 and correctly orientated LED **(1 mark)** R_2, R_3 and C_1 in series between power rails with C_1 **correctly orientated** **(1 mark)** For 6,7 and 2 connected, 5 not connected **(1 mark)** Component labelling **(1 mark)**	6	 Accept a mixture of identifiers and values Accept R notation

[END OF MARKING INSTRUCTIONS]