N5

National Qualifications
SPECIMEN ONLY

Mark

S860/75/01

Practical Electronics

Date — Not applicable

Duration — 1 hour

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day	Month	Year	Scottish candidate number

Total marks — 60

Attempt ALL questions.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

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.

Name	Symbol	Function
resistor	⊏▭⊐	limits current, drops voltage
	⊣⊢	stores charge
bipolar transistor		electronic switch
diode	▷⊢	
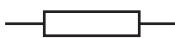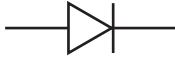
1. **(continued)**

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

brown   black   red   gold
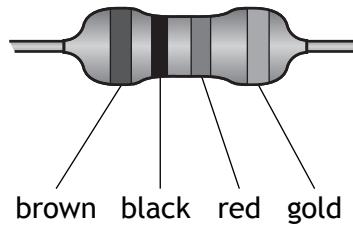
Using information in the data sheet:

(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
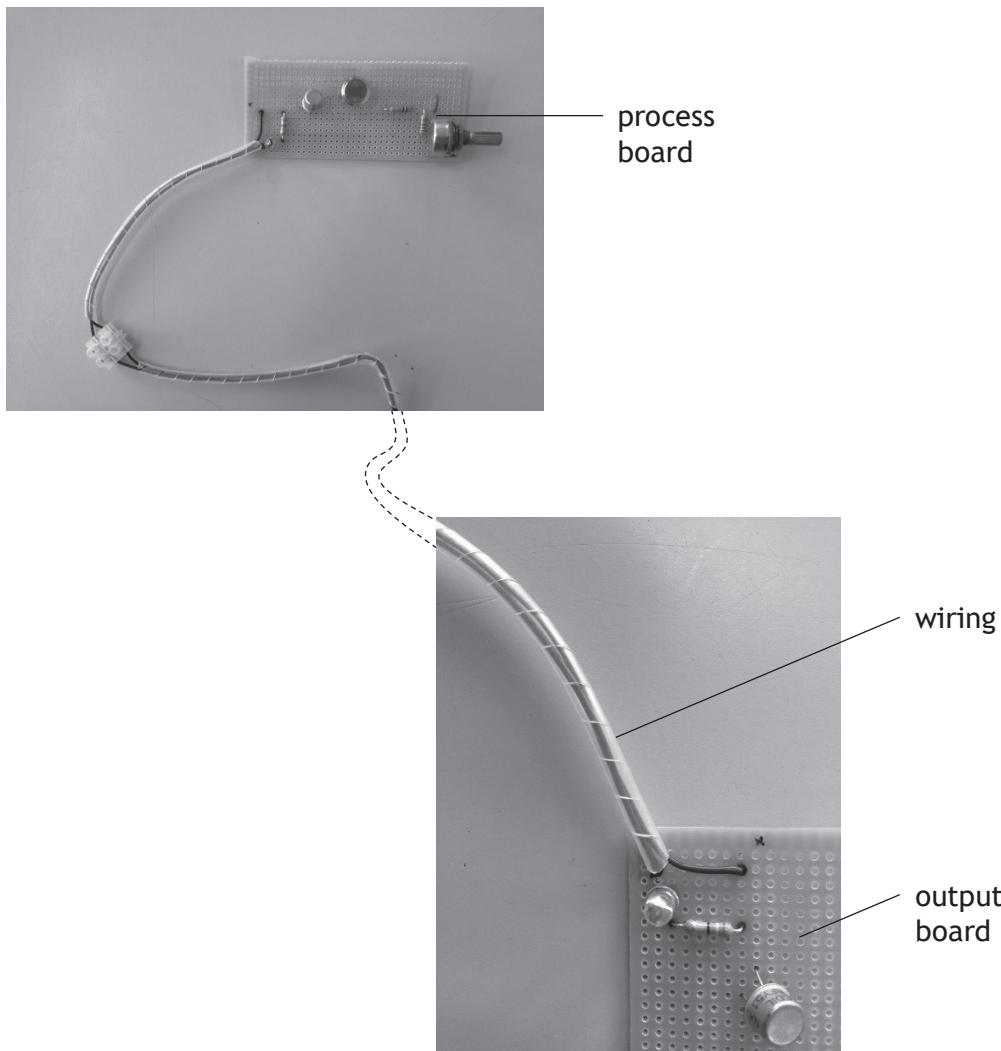
(a) Name the type of wiring shown which connects the two boards. **1**

(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

3. A student sets up a circuit as shown.

12 V

4 Ω

2 Ω

S   12 Ω
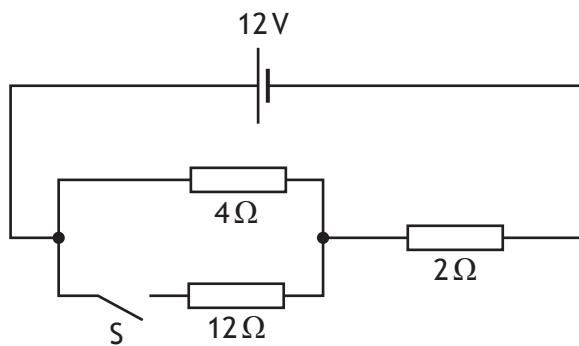
(a) Switch S is open.

   (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 ───┐
      ⊐o─ 0
0 ───┘

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

[Turn over

4. **(continued)**

(c)
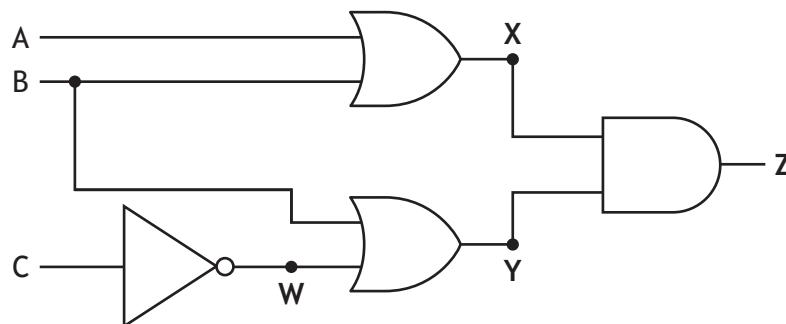
Complete the truth table for the circuit.   **4**

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*.)

**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

10   2   100   1

20   1   0·1

V/div   ms/div
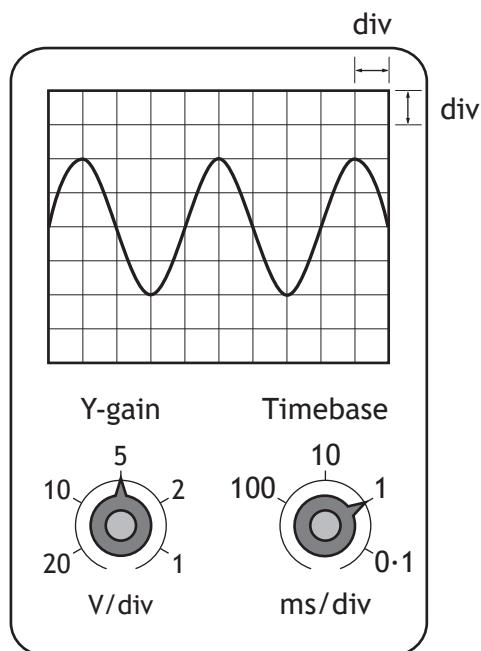
Determine the peak voltage of the signal.   **1**

[Turn over

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.

div

div

Y-gain

5
10   2
20   1
V/div

Timebase

10
100   1
0·1
ms/div
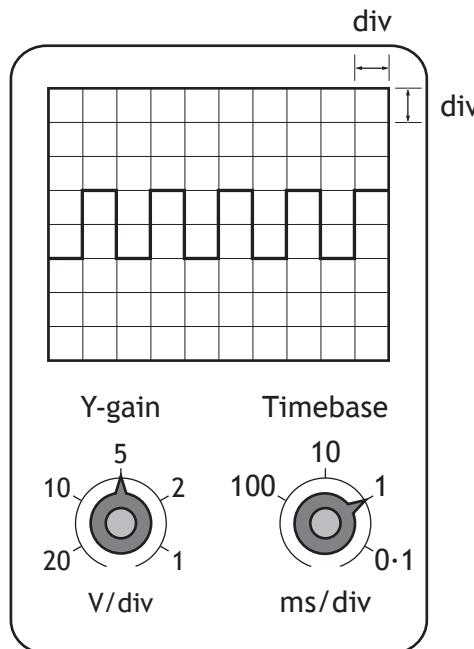
(i) State whether the signal is analogue or digital. **1**

(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.
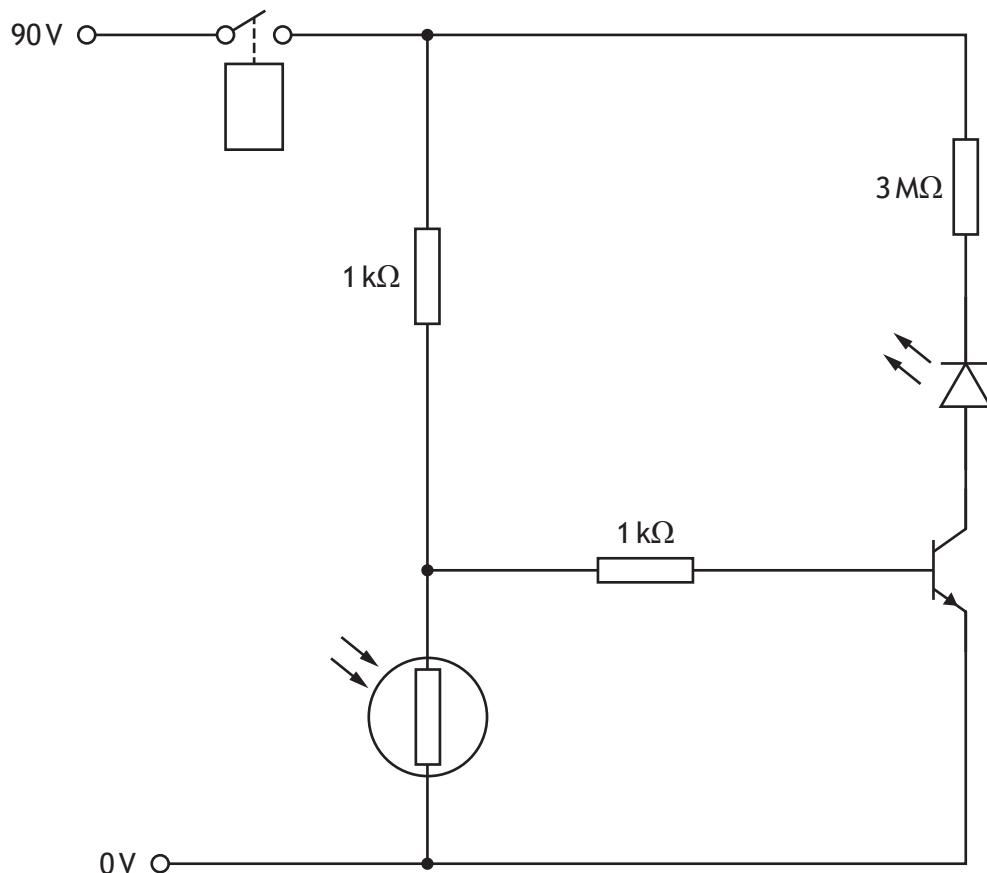

    Identify the **three** errors in the circuit.   **3**

6.   (continued)

(c)   The student also simulated the 555 timer circuit shown below.
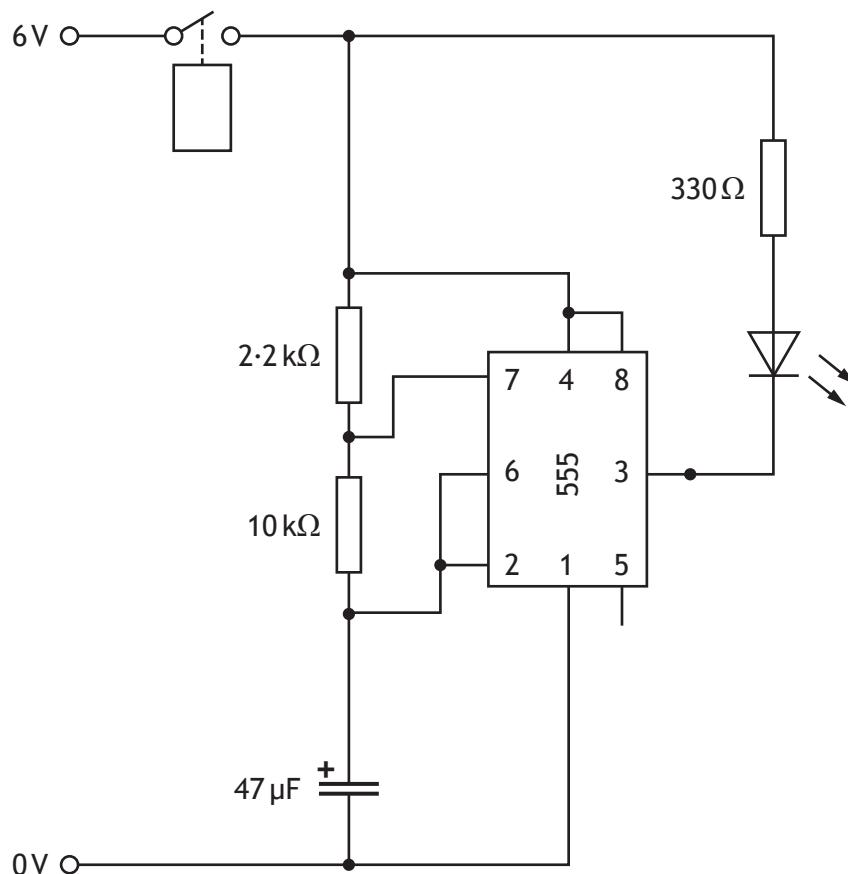
Complete the following table by giving **three** pre-power up checks for this circuit.

3

Pre-power up checklist
Check IC orientation

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 ─────────●──────────
```
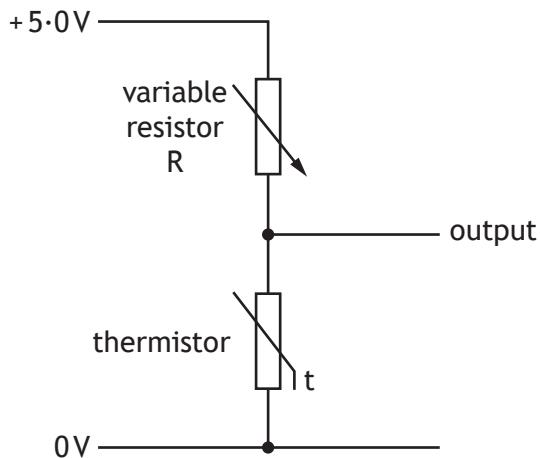
(a) (i) The graph shows how the resistance of the thermistor varies with temperature.
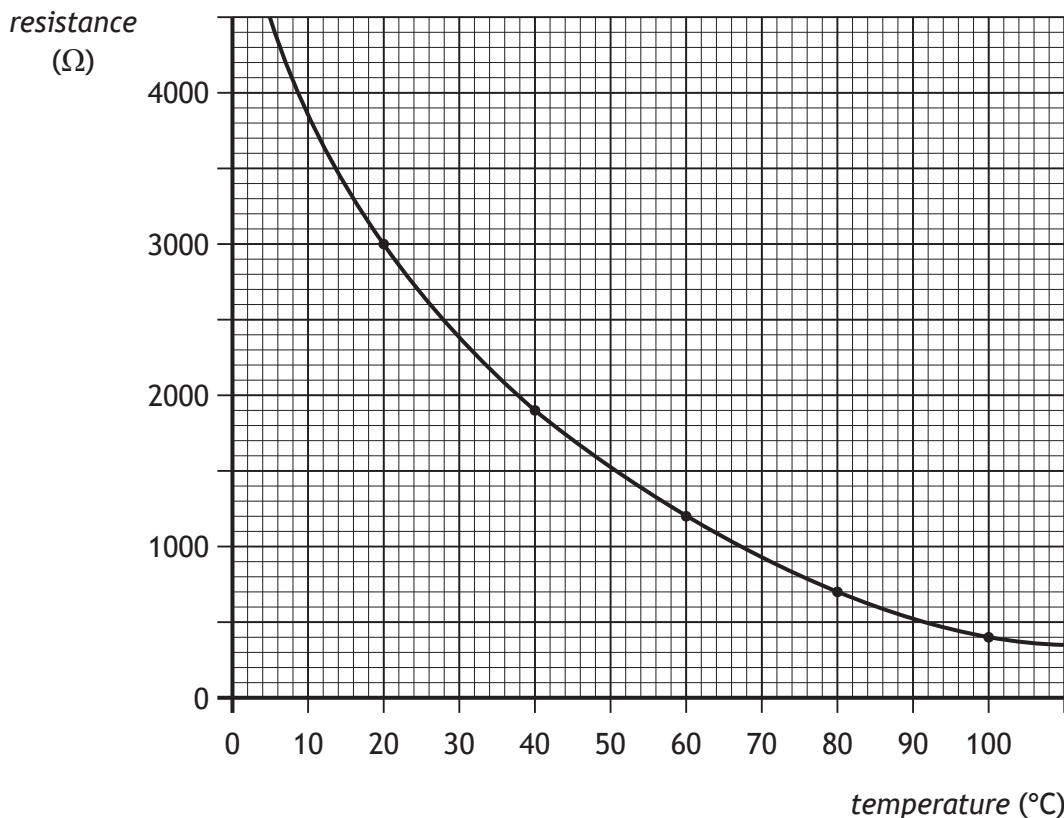
Use the graph to determine the resistance of the thermistor when the temperature is 60 °C. **1**

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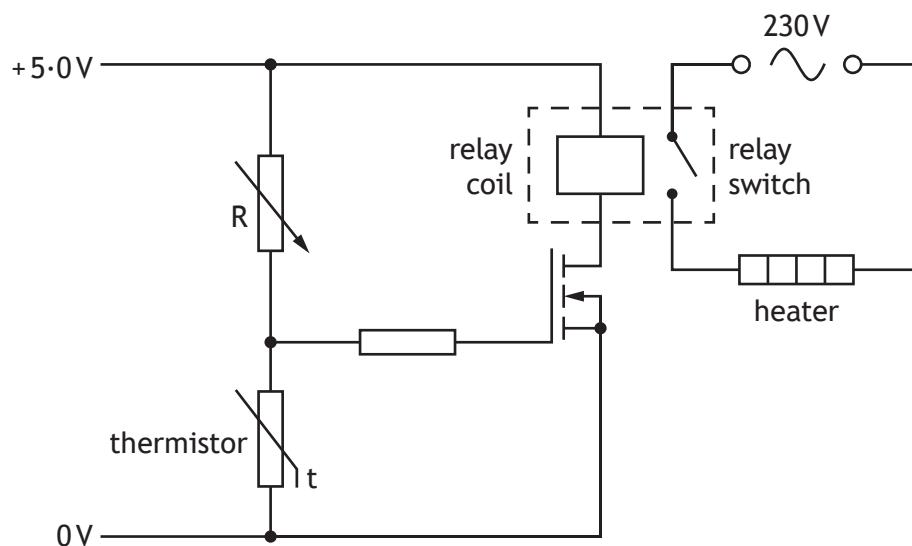
(i) Explain how the circuit operates to switch on the heater when the temperature falls below a certain value.

3

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

Name this component.

1

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 |
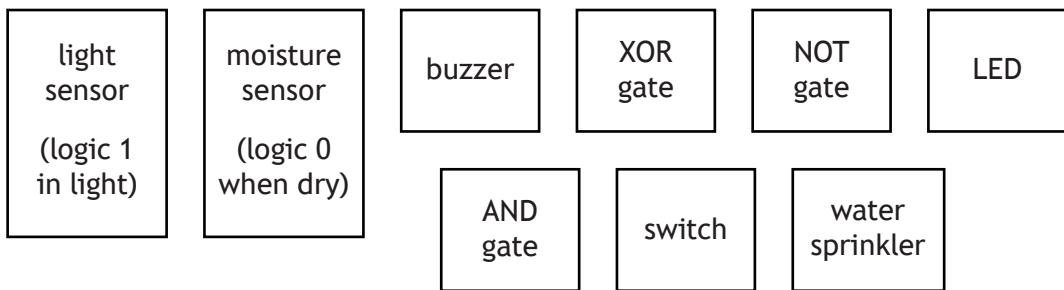
9. (a) State two precautions that should be taken when soldering. **2**

(b) For the circuit diagram shown, complete the layout diagram. **5**
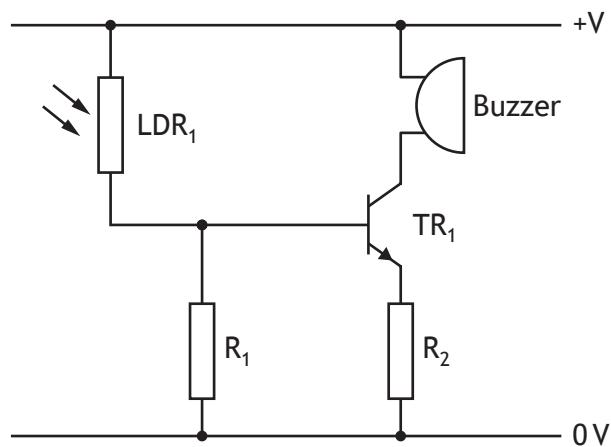
Component data

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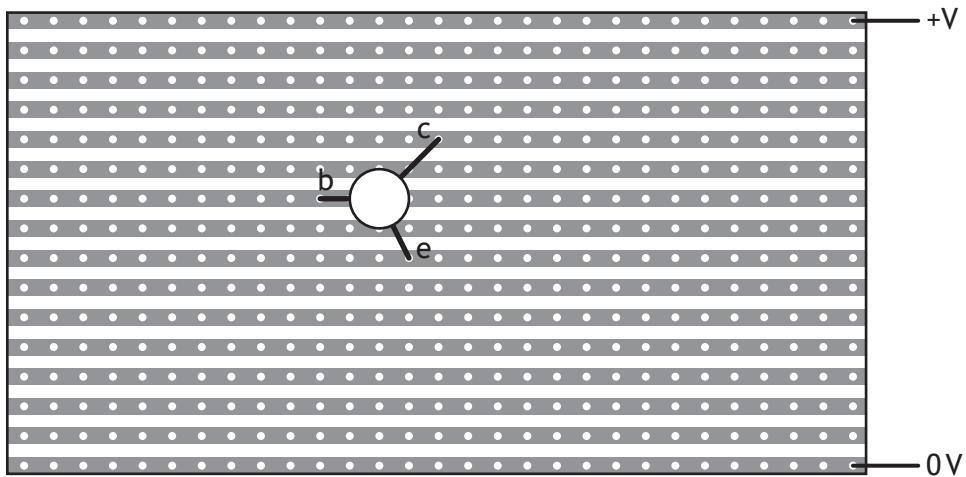
(Additional layout diagrams, if required, can be found on *page 19.*)

[END OF SPECIMEN QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL TRUTH TABLE FOR QUESTION 4 (c)

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				

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL LAYOUT DIAGRAMS FOR QUESTION 9 (b)
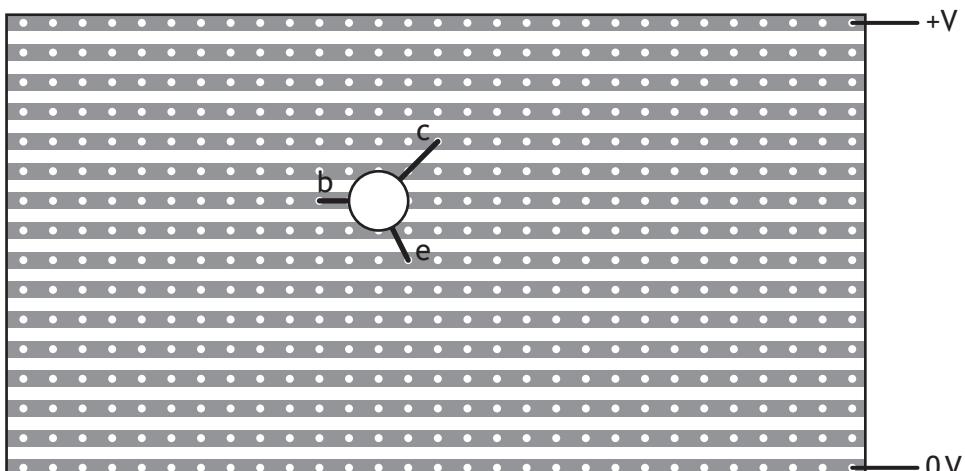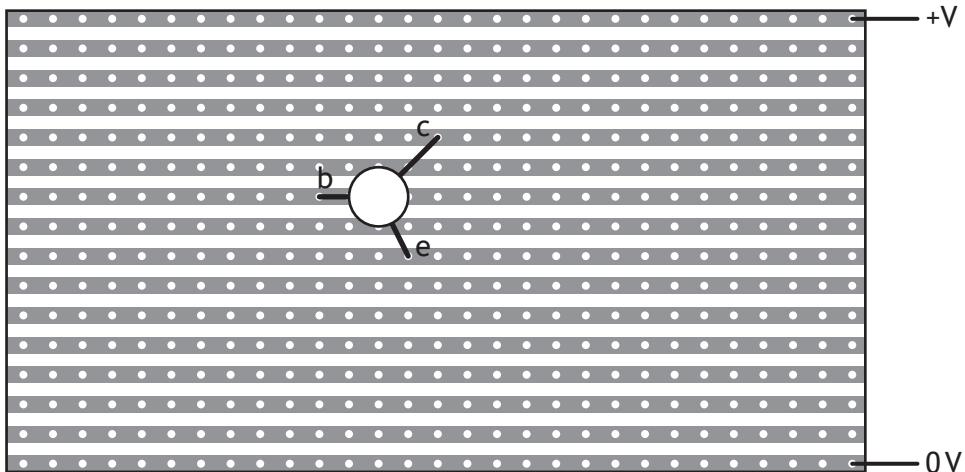
ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

N5

National
Qualifications
SPECIMEN ONLY

S860/75/11

Practical Electronics
Data Sheet

Date — Not applicable

Duration — 1 hour

S8607511

Relationships required for National 5 Practical Electronics

$$V = IR$$

$$R_T = R_1 + R_2 + ...$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$$

$$P = IV$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$V_2 = \frac{R_2}{R_1 + R_2} \times V_S$$

$$f = \frac{1}{T}$$

Resistor Colour Codes

4-band Resistor
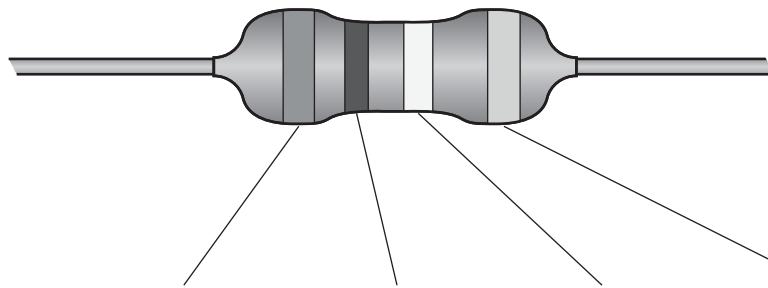
Colour	1st band value	2nd band value	Multiplier	Tolerances
Black	0	0	× 1	
Brown	1	1	× 10	±1%
Red	2	2	× 100	±2%
Orange	3	3	× 1000	±3%
Yellow	4	4	× 10000	±4%
Green	5	5	× 100000	±0·5%
Blue	6	6	× 1000000	±0·25%
Violet	7	7	× 10000000	±0·10%
Grey	8	8	× 100000000	±0·05%
White	9	9	× 1000000000	
Gold			× 0·1	±5%
Silver			× 0·01	±10%
No band				±20%

IC Pinout diagrams

741 Op. Amp.

Offset Null	1		8	Not Connected (NC)
Inverting (−)	2		7	V+ (Power)
Non-Inverting (+)	3		6	Output
(Power) V−	4		5	Offset Null

741 Op-amp

555

Ground	1		8	Power Supply (Vcc)
Trigger	2		7	Discharge
Output	3		6	Threshold
Reset	4		5	Control Voltage
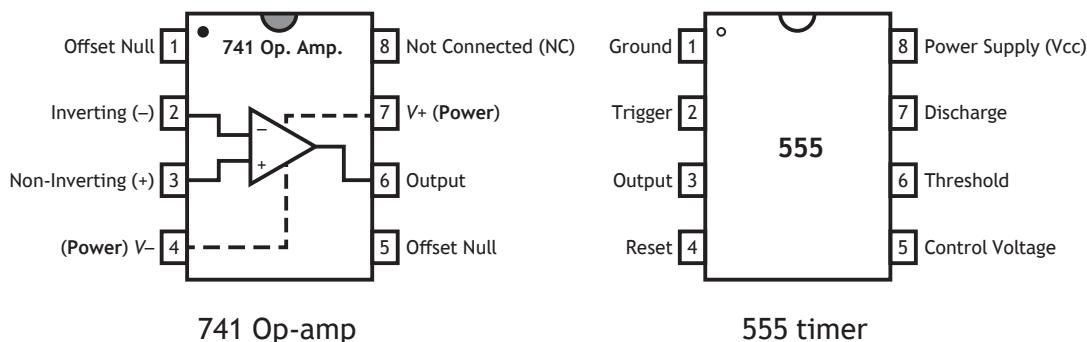
555 timer
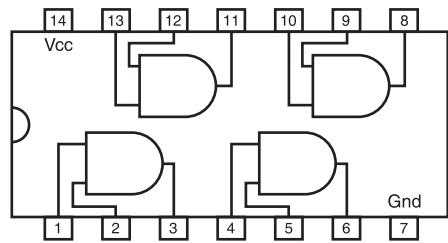
7408 Quad 2 input
AND Gates
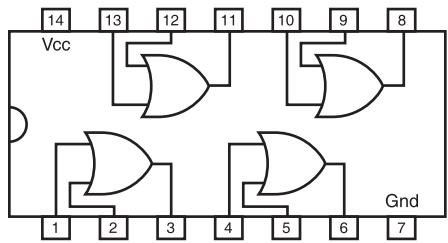
7432 Quad 2 input
OR Gates
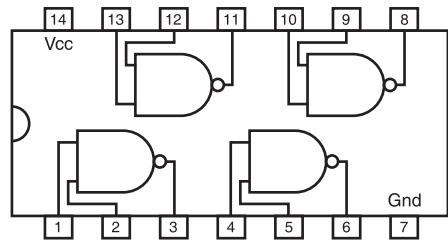
7400 Quad 2 input
NAND Gates
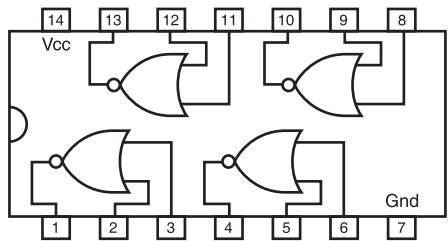
7402 Quad 2 input
NOR Gates
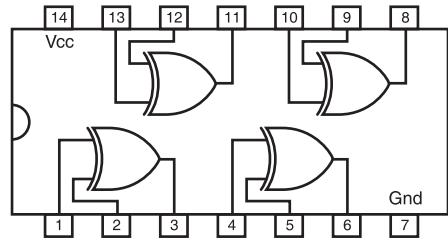
7486 Quad 2 input
XOR Gates
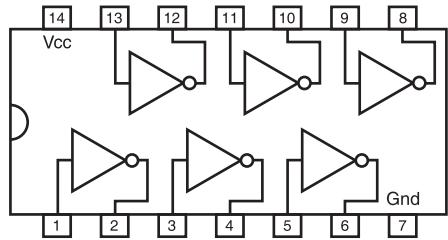
7404 Hex NOT Gates
(Inverters)

N5

National
Qualifications

S860/75/01

Practical Electronics

Marking Instructions

SQA ©

General marking principles for National 5 Practical Electronics

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the detailed marking instructions (MIs) for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

When marking National 5 Practical Electronics, there are some common issues which arise when considering candidates' answers.

There is often a range of acceptable answers which would sensibly answer a particular question. However, it is often difficult to anticipate all correct or partially correct responses to questions.

The answers given in the MIs represent ideal answers.

Additional acceptable answers are also given in the MIs to offer guidance to assist interpreting candidates' answers.

Also, advice on answers which are NOT acceptable or only attract partial marks may also be given in the MIs for some questions.

Markers are reminded that marks for each candidate response must always be assigned in accordance with the general marking principles and the specific marking instructions for the relevant question.

(d) There are **no half marks** awarded.

(e) **In calculations**, marks should be awarded for non-standard symbols where the symbols are defined and the relationship is correct, or where the substitution shows that the relationship used is correct. This must be clear and unambiguous.

(f) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units if required) on its own.

(g) Marks are provided for knowledge of relevant formulae alone. When a candidate writes down several formulae and does not select the correct one to continue with, for example by substituting values, no mark can be awarded.

(h) Where a wrong answer to part of a question is carried forward and the wrong answer is then used correctly in the following part, the candidate should be given credit for the subsequent part or 'follow on'.

(i) Rounding to an expected number of significant figures, the mark can be awarded for answers which have up to two figures more or one figure less than the number in the data with the fewest significant figures. (Note: the use of a recurrence dot, eg $\dot{3}$, would imply an infinite number of significant figures and would therefore not be acceptable.)

(j) Where a question asks for or requires a specific number of reasons, examples, points, etc and the candidate provides more than the required number of responses then each incorrect response negates a correct response.

(k) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify**, **name**, **give**, or **state**, they need only name or present in brief form;
- **draw,** they must provide or complete a drawing, eg a circuit diagram, layout diagram or logic diagram;
- **complete**, they must complete the response, eg completing a truth table, layout diagram, checklist, etc;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **determine** or **calculate**, they must determine a number from given facts, figures or information;
- **estimate**, they must determine an approximate value for something;
- **justify**, they must give reasons to support their suggestions or conclusions, eg this might be by identifying an appropriate relationship and the effect of changing variables;
- **show that**, they must use electronics (and mathematics) to prove something, eg a given value — *all steps, including the stated answer, must be shown*;
- **predict**, they must suggest what may happen based on available information;
- **suggest**, they must apply their knowledge and understanding of electronics to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of electronics.

Common issues with candidate responses:

Spelling

The incorrect spelling of technical terms should be ignored and candidates should be awarded the relevant mark. If answers can be interpreted and understood without any doubt as to the meaning, then the answer should be marked according to the MIs.

However, care should be taken to ensure that the incorrect spelling does not make the response ambiguous, leading to possible 'wrong electronics'. For example 'use a smaller resistor' instead of 'use a smaller resistance' is ambiguous, since a smaller resistor may not have a smaller resistance.

If the spelling (or handwriting) in an answer makes it difficult for you to interpret a candidate's intention, then do not award the mark.

Units

Use of R notation is acceptable eg 270R, 4k7, 6M8, etc.

For **numerical** and **non-numerical** answers which require a unit to be **stated** in an answer, the incorrect spelling of the unit is not usually penalised (if the unit can be clearly identified).

eg 'State the unit of capacitance.' Answer: 'farad'. The answer: 'farrads' would be acceptable.

Also for **numerical** and **non-numerical** answers, do not penalise upper/lower casing when the abbreviated version is given eg v, f, hZ.

Ohms (Ω) is an exception, ω would not be an acceptable abbreviation.

However, for **numerical answers**, care must be taken to ensure the unit has the correct prefix, eg for an answer t = 0·005 seconds, t = 5 ms is acceptable but NOT t = 5 Ms.

Some common units often attract wrong abbreviations in answers to numerical questions. When the abbreviation can be confused with a different unit then this would attract a unit penalty, eg sec or secs as an abbreviation for seconds is NOT acceptable.

Standard form:

Candidates may fail to express an answer in standard form correctly.

For an answer t = 400 000 s, then t = 4×10^5 s would be correct but t = 4^5 s would be treated as an arithmetic error and the final mark would not be awarded.

Relationship (equation) selection:

No marks should be awarded if a 'magic triangle', eg , was the only statement in a candidate's response.
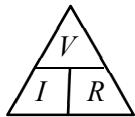
The correct relationship must be stated, eg $V = IR$ or $R = \dfrac{V}{I}$, to gain (1) mark.

Incorrect answer carried forward:

Where an incorrect answer to a part of a question is carried forward

- within that part of the question, eg (a)(i) and (a)(ii)
- to the next part of the question, eg (a) and (b)

this should incur no further penalty, provided that it is used correctly.

Where a question requires a data value and the candidate has selected the wrong value, then either the candidate's wrong value may be used OR the correct data value in the subsequent answer and the response could gain full marks if correctly completed.

Example:

(a) State the tolerance in the resistance of a resistor with a gold tolerance band.

Candidate's answer: 2%. This answer would attract zero marks.

(b) Calculate the maximum and minimum possible resistances of the resistor.

Candidate may use either the value given in part (a) OR the correct value for the tolerance and could gain full marks if correctly completed.

The 'Additional guidance' column of the MIs would indicate the comment 'or consistent with part...' to indicate that an incorrect answer may be carried forward.

Standard three marker:

The examples below set out how to apportion marks to answers requiring calculations. These are the '**standard three marker**' type of questions.

Unless a numerical question specifically requires evidence of working to be shown, full marks should be given for a **correct** answer to a numerical question even if the steps are not shown explicitly. The individual marks shown below are for use when marking partially correct answers.

Markers who are new to marking SQA Practical Electronics exams should study these issues closely, since the guidance illustrates common faults in candidates' answers to the 'standard three marker' type of question. Items 1–15 below illustrate how to apportion marks accordingly.

Experienced markers should also re-acquaint themselves with these examples before marking.

For some questions requiring numerical calculations, there may be alternative methods (eg alternative relationships) which would lead to a correct answer. These alternative methods of reaching the answer and how to apportion marks are also included in the specific MIs for these questions.

Sometimes, a question requires a calculation which does not fit into the 'standard three marker' type of response. Full guidance on how to apportion marks will be given in the MIs for that specific question.

Question:

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts.
Calculate the resistance of the resistor. (3 marks)

Candidate answer	**Mark + Comment**

1. $V = IR$
    $7·5 = 1·5R$
    $R = 5·0\ \Omega$

1 mark: formula
1 mark: substitution
1 mark: correct answer

2. $5·0\ \Omega$

3 marks: correct answer

3. $5·0$

2 marks: unit missing

4. $4·0\ \Omega$

0 marks: no evidence, wrong answer

5. $\_\_\ \Omega$

0 marks: no working or final answer

6. $R = \dfrac{V}{I} = \dfrac{7·5}{1·5} = 4·0\ \Omega$

2 marks: arithmetic error

7. $R = \dfrac{V}{I} = 4·0\ \Omega$

1 mark: formula only

8. $R = \dfrac{V}{I} = \_\_\ \Omega$

1 mark: formula only

9. $R = \dfrac{V}{I} = \dfrac{7·5}{1·5} = \_\_\ \Omega$

2 marks: formula & substitution, no final answer

10. $R = \dfrac{V}{I} = \dfrac{7·5}{1·5} = 4·0$

2 marks: formula & substitution, wrong answer

11. $R = \dfrac{V}{I} = \dfrac{1·5}{7·5} = 5·0\ \Omega$

1 mark: formula but wrong substitution

12. $R = \dfrac{V}{I} = \dfrac{75}{1·5} = 5·0\ \Omega$

1 mark: formula but wrong substitution

13. $R = \dfrac{I}{V} = \dfrac{1·5}{7·5} = 5·0\ \Omega$

0 marks: wrong formula

14. $V=IR$
    $7·5 = 1·5 \times R$
    $R = 0·2\ \Omega$

2 marks: formula & substitution, arithmetic error

15. $V=IR$
    $R = \dfrac{I}{V} = \dfrac{1·5}{7·5} = 0·2\ \Omega$

1 mark: formula correct but wrong rearrangement of symbols

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		
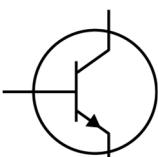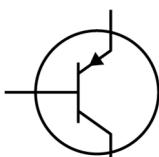
Question			Answer	Max mark	Additional guidance
3.	(a)	(i)	6 Ω	1	Unit required.
		(ii)	$V = IR$ 1 $12 = I \times 6$ 1 $I = 2$ A 1	3	Or consistent with (a)(i)
	(b)	(i)	$\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ 1 $\dfrac{1}{R} = \dfrac{1}{4} + \dfrac{1}{12}$ 1 $R_T = 3$ Ω 1	3	$R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ 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)		(see table below)	4	

W	X	Y	Z
1	0	1	0
0	0	0	0
1	1	1	1
0	1	1	1
1	1	1	1
0	1	0	0
1	1	1	1
0	1	1	1

1 mark for each correct column.
Apply follow through between columns.

Question			Answer	Max mark	Additional guidance
5.	(a)		10 V	**1**	
	(b)	(i)	digital	**1**	
		(ii)	T = (2 × 1 ms =) 2 ms 1 $f = \dfrac{1}{T}$ 1 f = 500 Hz 1	**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 0·5 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 protective resistance for LED is too large 1 LED connected wrong way round 1	**3**	
	(c)		orientation of capacitor orientation of LED supply voltage resistance values Any three for 1 mark each.	**3**	

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 $V_1 = \dfrac{1200}{1200 + 800} \times 5 \cdot 0$ 1 $V_1 = 3$ V 1	**3**	Or consistent with (a)(i) Using Ohm's law: $R_T (= 1200 + 800) = 2000$ $I = \dfrac{V}{R}$ $I = \dfrac{5 \cdot 0}{2000}$ $I = 2 \cdot 5 \times 10^{-3}$ 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 Transistor switches on at a certain voltage/2 V. 1 Relay activates and closes contacts in heater circuit. 1	**3**	If transistor switching voltage is given as 0·7 V award a maximum of 2 marks.
		(ii)	diode	**1**	
8.			1 mark for selecting both input devices 1 mark for selecting correct gates 1 mark for selecting both output devices 1 mark for correctly linking the inputs and gates 1 mark for correctly linking the outputs to the gates (arrows are NOT required on the connections) 1 mark for correctly identifying the three sections of the system	**6**	

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]