Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GENERAL CERTIFICATE OF SECONDARY EDUCATION

1957/04

DESIGN AND TECHNOLOGY

Systems & Control Technology (Electronics Option)
Paper 4 (Higher Tier)

WEDNESDAY 26 MAY 2010: Afternoon

DURATION: 1 hour 15 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

None

READ INSTRUCTIONS OVERLEAF

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INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully and make sure that you know what you have to do before starting your answer.**
- **Answer ALL the questions.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).**
- **Show all working for calculations.**
- **All necessary formulae are provided within the questions. No extra formulae sheet is required.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 50.**
- **Marks will be awarded for the use of correct conventions.**
- **Dimensions are in mm unless stated otherwise.**

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1 Electronic product cases normally need holes drilling to allow the fitting of switches and external components.
2D CAD software has been used to draw a drill template.

(a) State TWO benefits of using CAD, rather than hand drawing, for the drill template design.

Benefit 1 _____ **[1]**

Benefit 2 _____ **[1]**

(b) Holes to match those in a PCB are included in the CAD drawing of a template shown in Fig. 1.

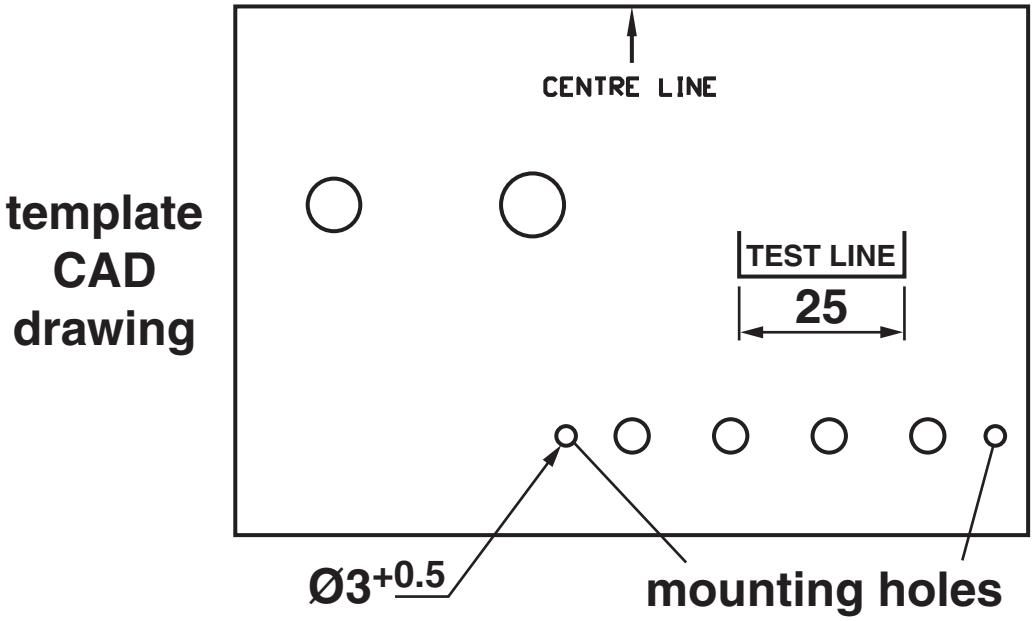
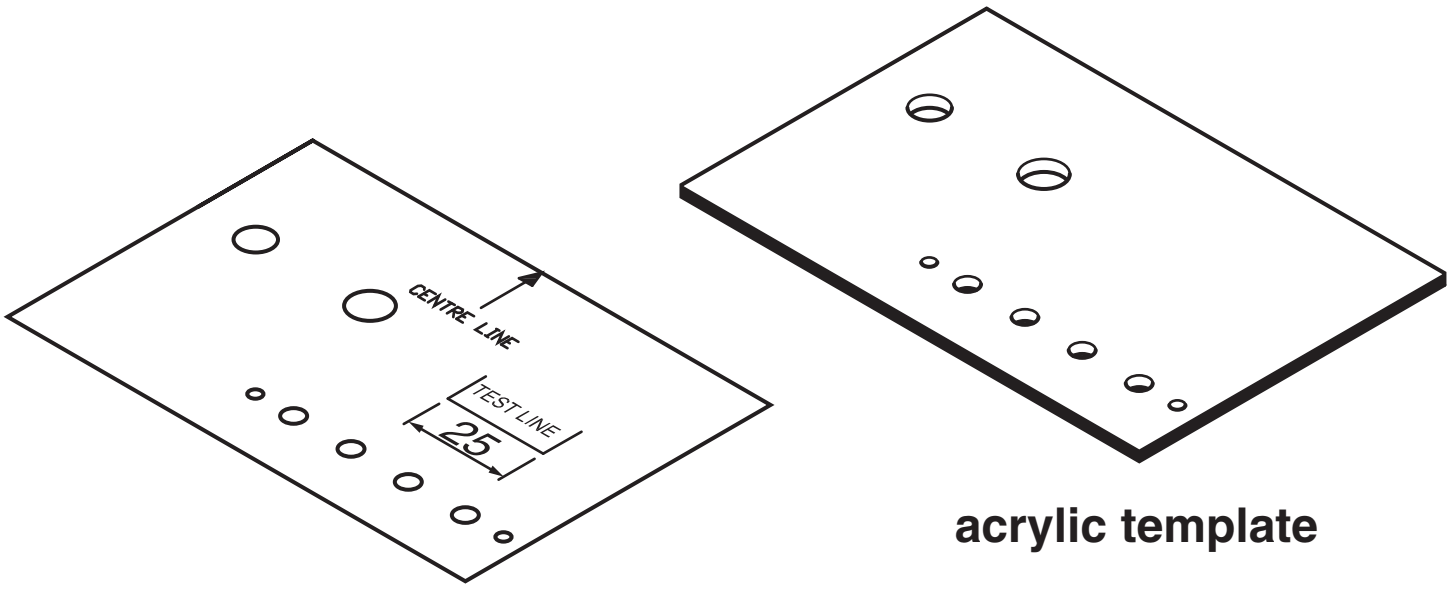


Fig. 1

The diameter of the mounting holes for the PCB is shown on the drawing as Ø3$^{+0.5}$, giving a tolerance of +0.5 mm.
Give the likely reason for allowing a tolerance on the hole diameter.

Reason _____ **[1]**

(c) Output from the CAD drawing can be printed as a paper template or used in a laser cutter for production of an acrylic template.
Fig. 2 shows both outputs.



acrylic template

paper template

Fig. 2

(i) Give <u>ONE</u> method of checking the accuracy of the paper template before use.

_____ **[1]**

(ii) Explain why the laser cut template is likely to be more accurate in use than the paper template.

_____

_____

_____

_____ **[2]**

(iii) **Fig. 3 shows the laser cut template and the case lid that is to be drilled.**

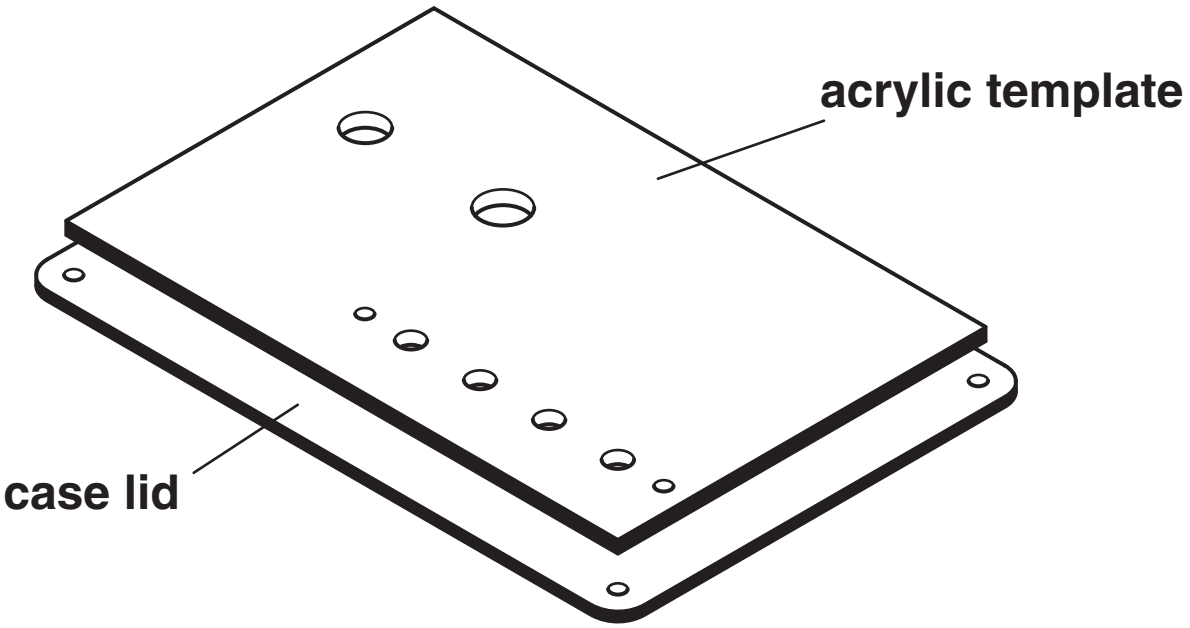


Fig. 3

Use notes or sketches to show a method of accurately securing the acrylic template to ensure that all the holes line up.

[2]

(d) When an electronic product is no longer required it should be possible to recycle the materials. Give <u>TWO</u> pieces of information that should be included on the case to make recycling easier.

1 _____

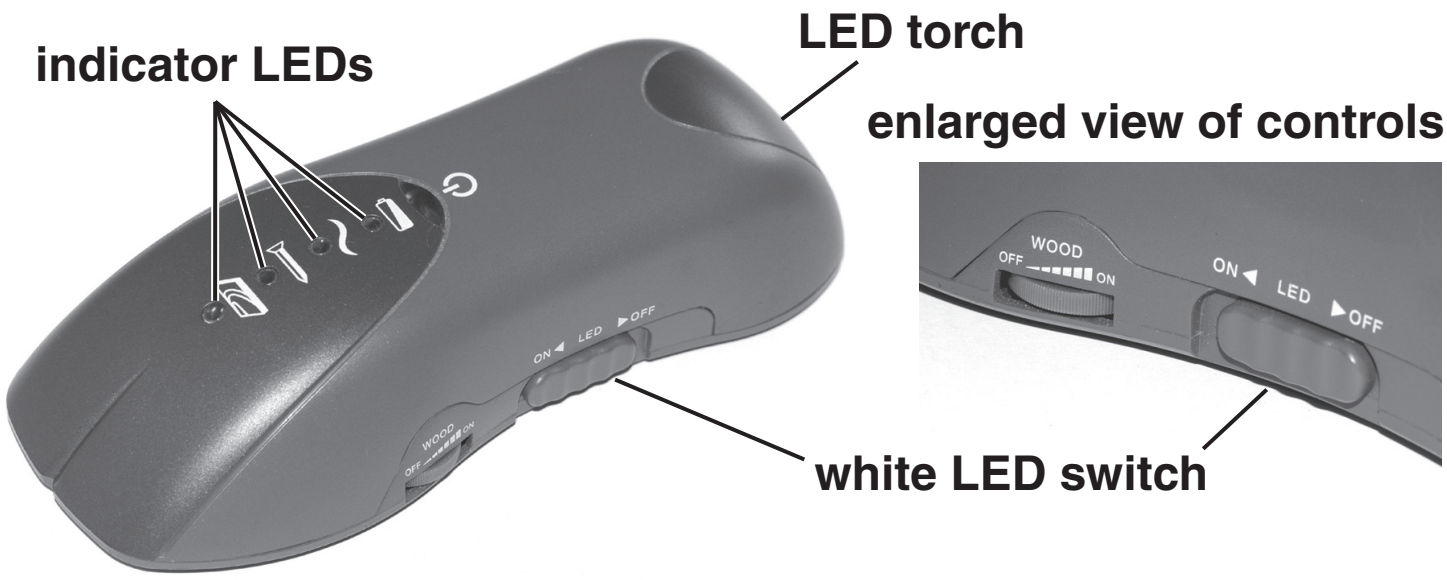
_____ **[1]**

2 _____

_____ **[1]**

[Total: 10]

2 Fig. 4 shows a hand held detector used for finding concealed mains cable, other metals and timber framing.
The device is powered by a 9V battery and includes a white LED torch.



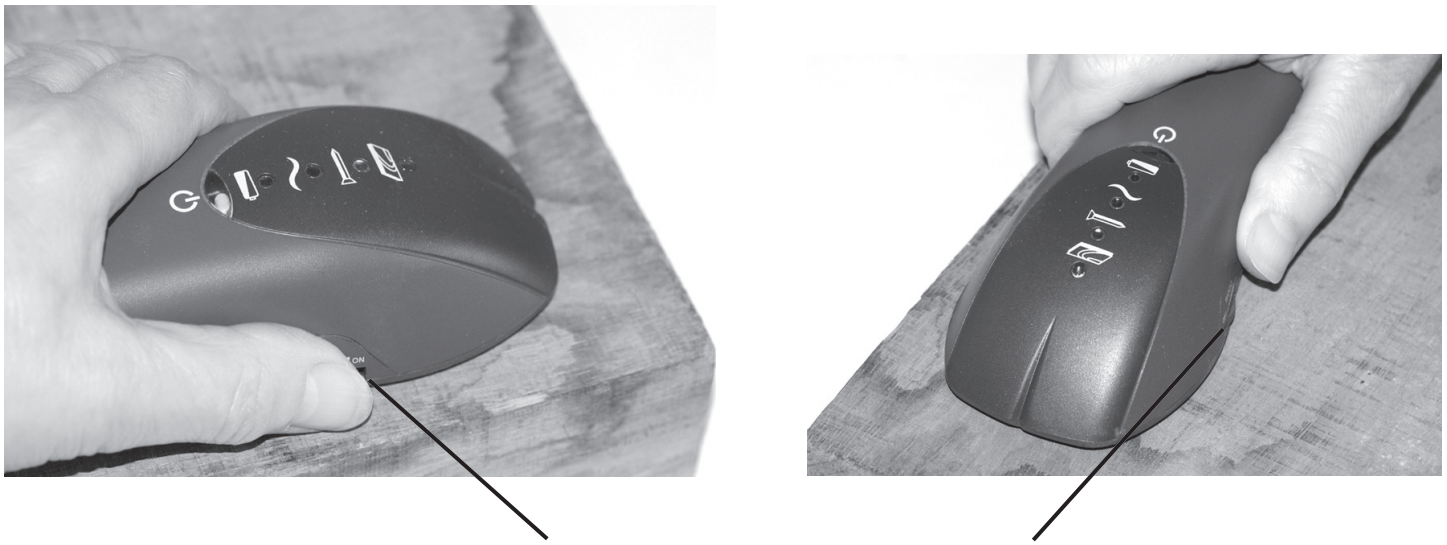


Fig. 4

(a) Give TWO factors that contribute to the ergonomic design of the detector.

1 _____

_____ **[1]**

2 _____

_____ **[1]**

(b) The case is injection moulded with the base held in place by self tapping screws as shown in Fig. 5.

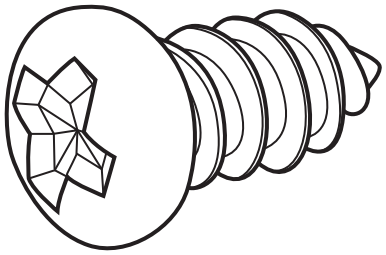


Fig. 5

(i) Give ONE reason for using self tapping screws to secure the base during manufacture.

_____

_____ **[1]**

(ii) State why the symbols next to the indicator LEDs and controls in Fig. 4 must have been applied after the moulding had taken place.

_____

_____ **[1]**

(c) Fig. 6 shows a view of the circuit board.

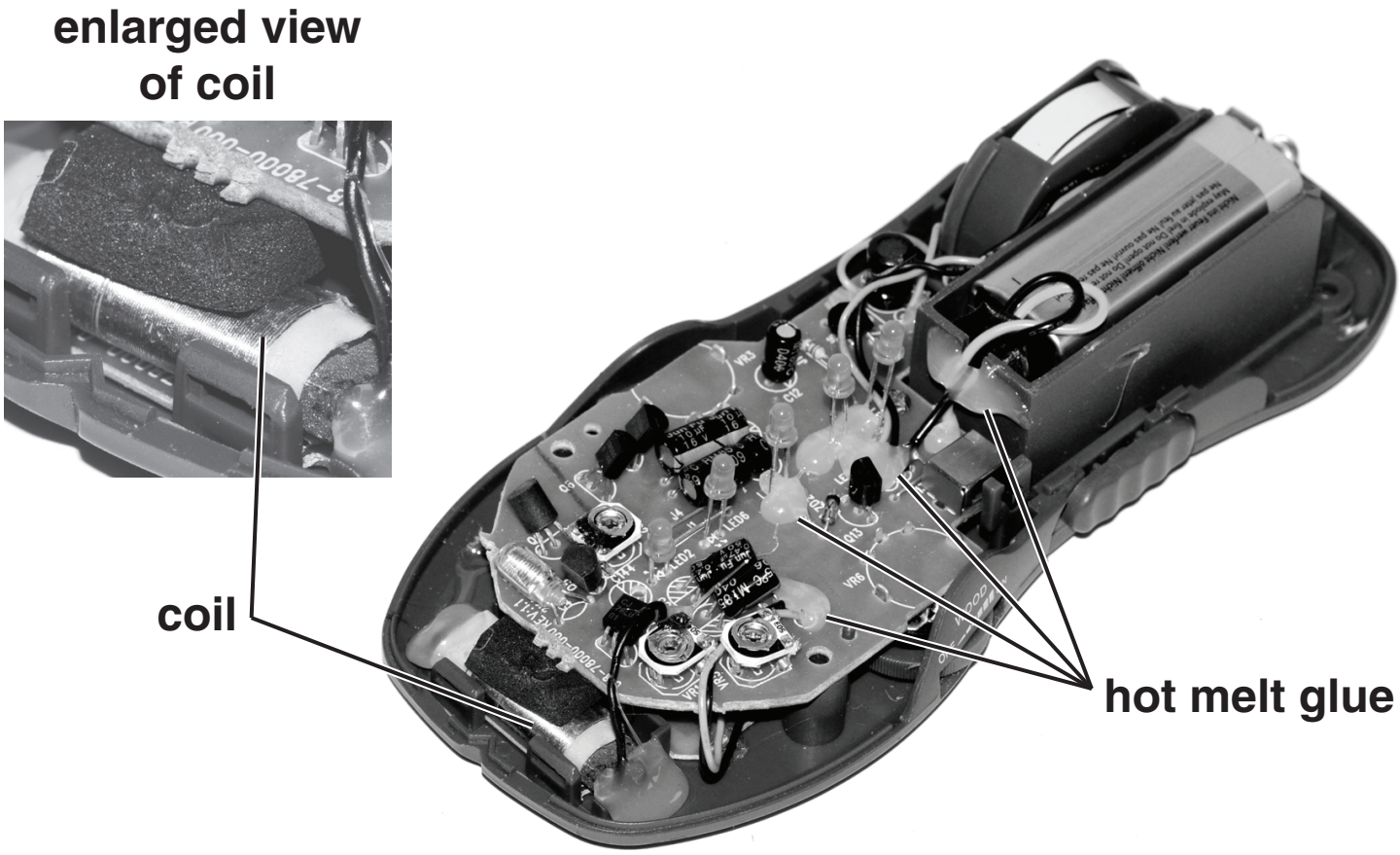


Fig. 6

(i) Give <u>ONE</u> reason for connecting wires being held in place with hot melt glue.

_____

_____ **[1]**

(ii) The sensor for the detector uses enamelled copper wire in a coil.
State a reason for the use of enamel on the copper wire.

_____

_____

_____ **[1]**

(d) Fig. 7 shows the LED indicators on the circuit board.
The LEDs have been soldered into position at varying heights to match the curve of the case.

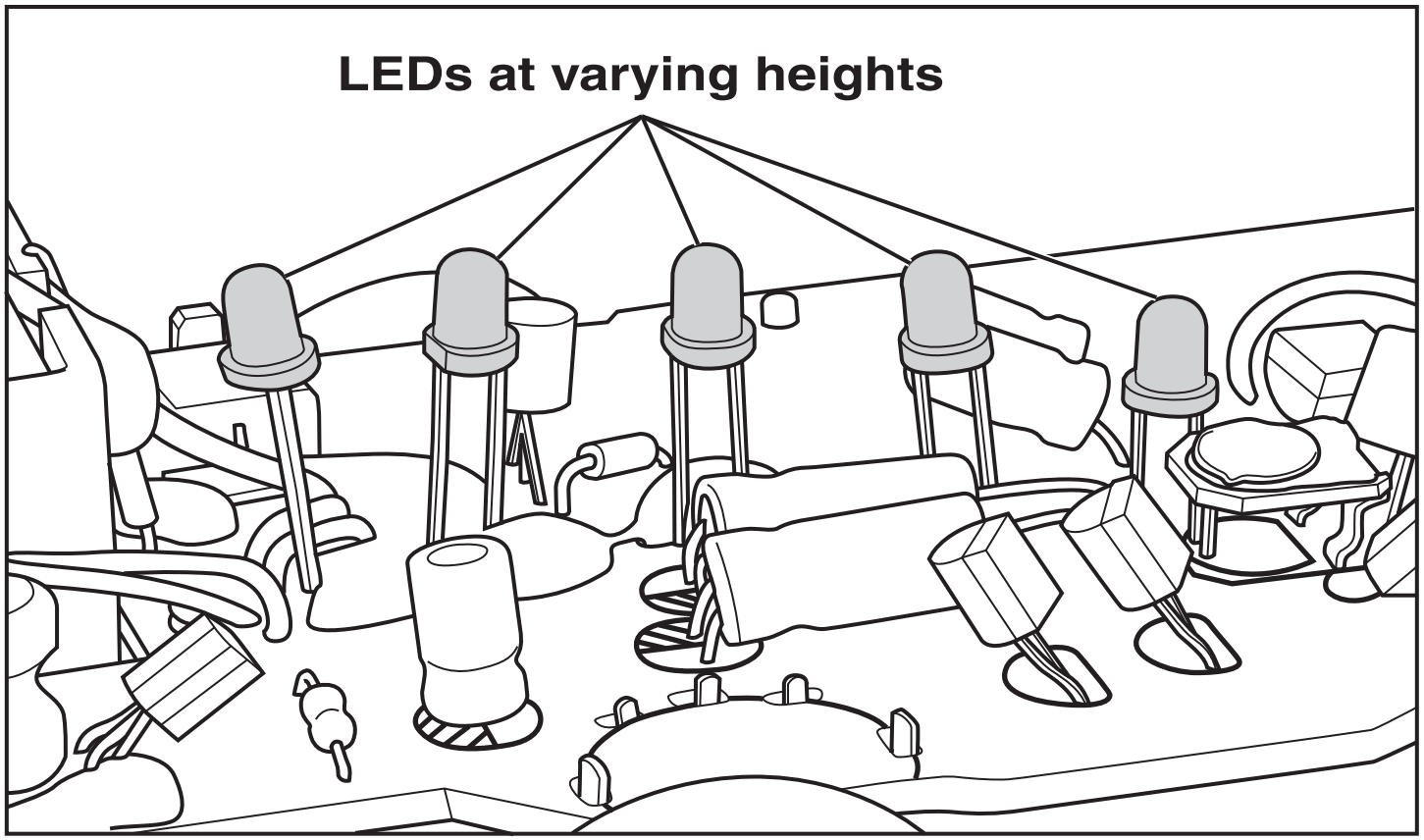


Fig. 7

(i) Use notes or sketches to describe how the LED heights could be accurately controlled when assembling a batch of boards.

[2]

(ii) Fig. 8 shows two radial capacitors on the circuit board, bent to a horizontal position.

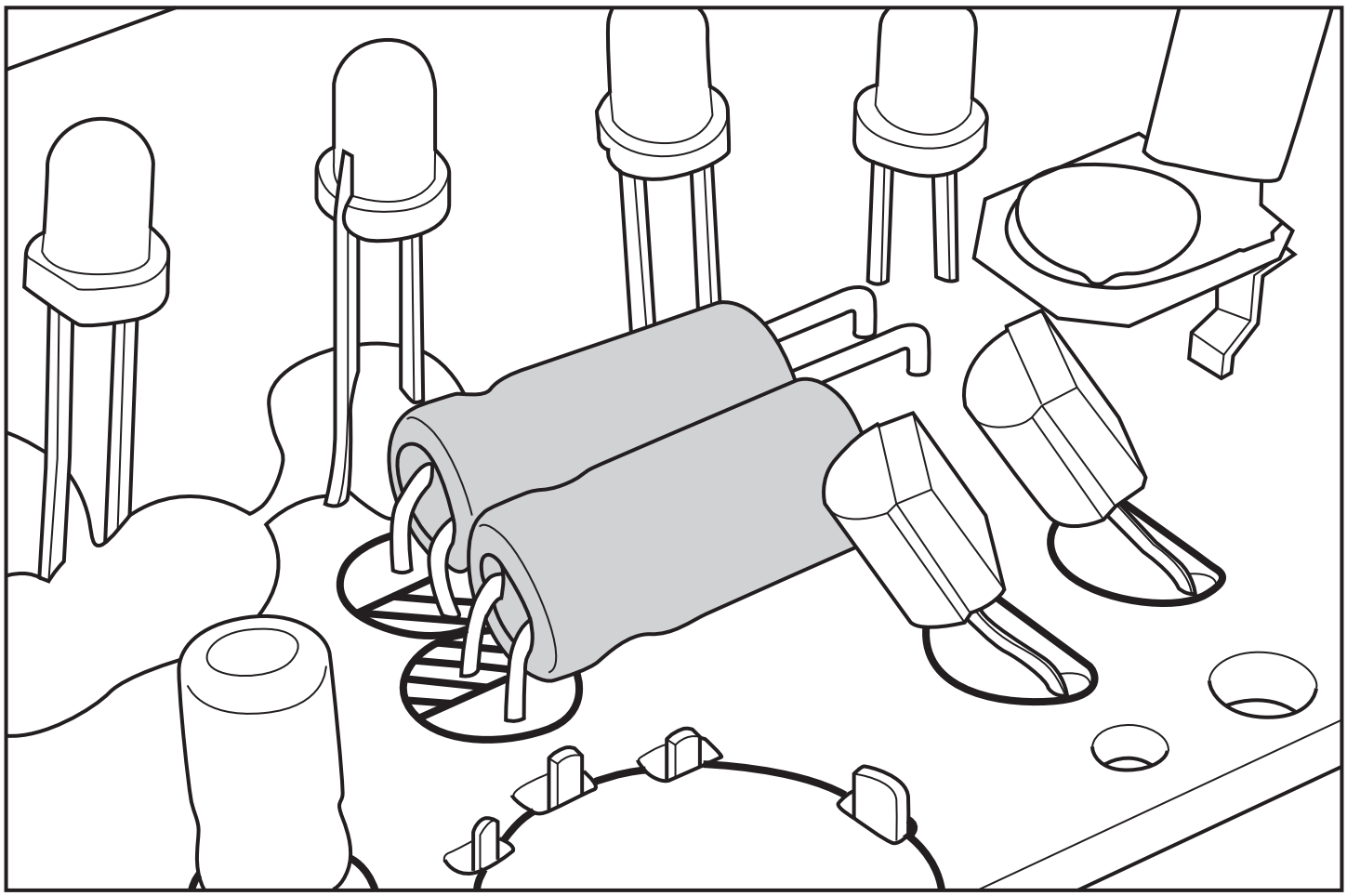


Fig. 8

Explain why it may be better to use either shorter radial capacitors or axial capacitors.

_____

_____

_____

_____ **[2]**

[Total: 10]

3 **The water temperature in a tropical fish tank has to be carefully controlled.**
Fig. 9 shows the thermistor to be used for sensing the temperature of the water.

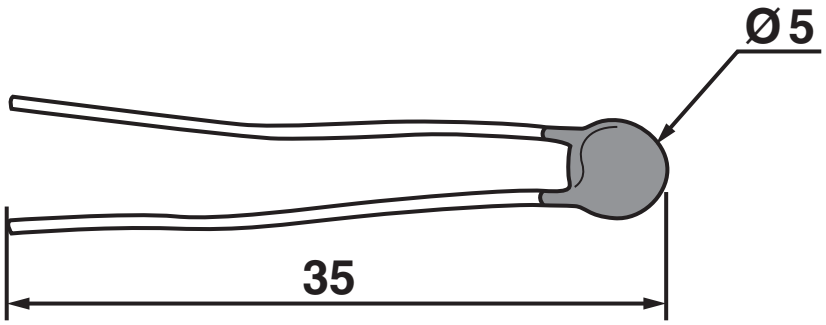


Fig. 9

(a) Use notes or sketches to describe a method of protecting the thermistor from water when it is placed in the tank.

[3]

(b) The signal from the thermistor is taken to TWO comparators as shown in Fig. 10.

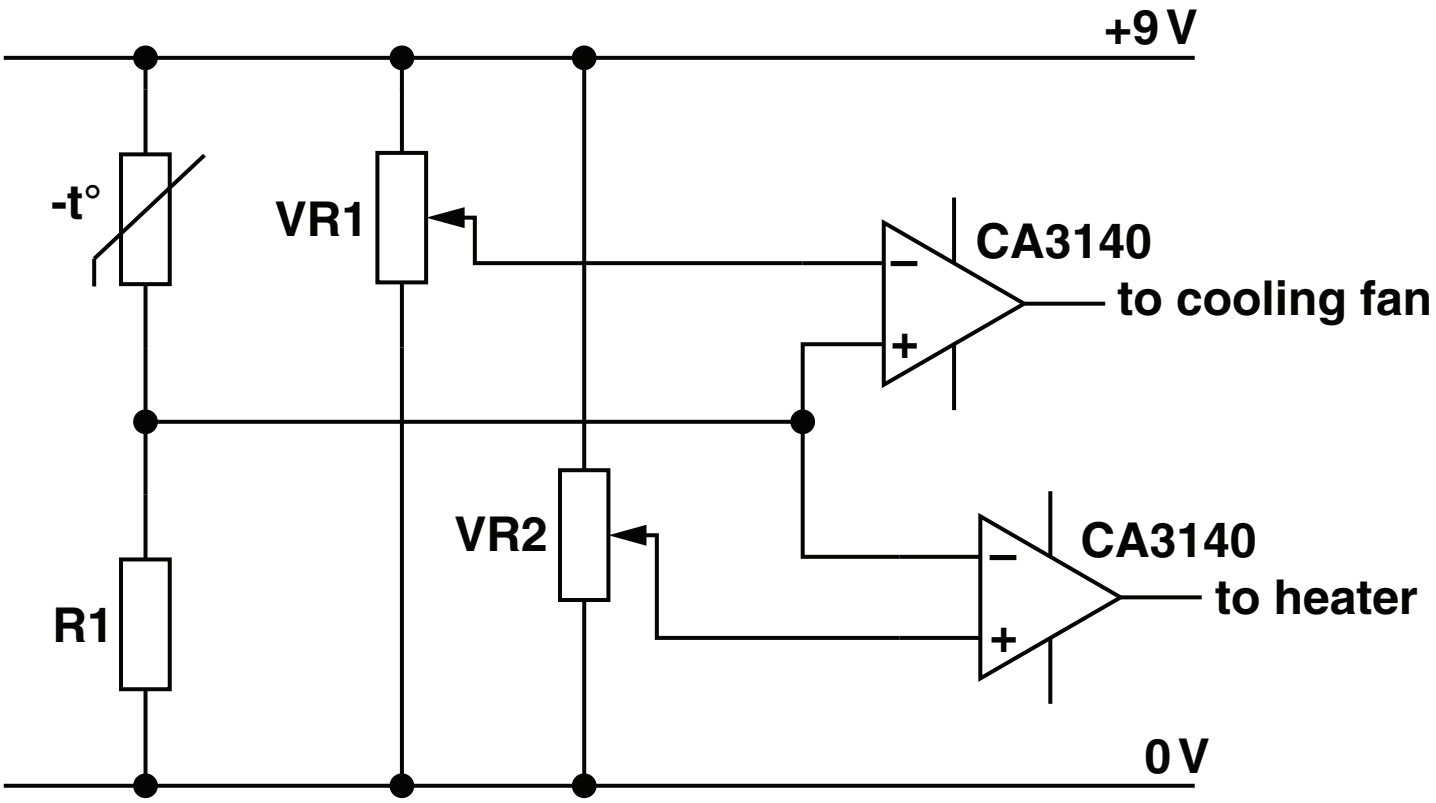


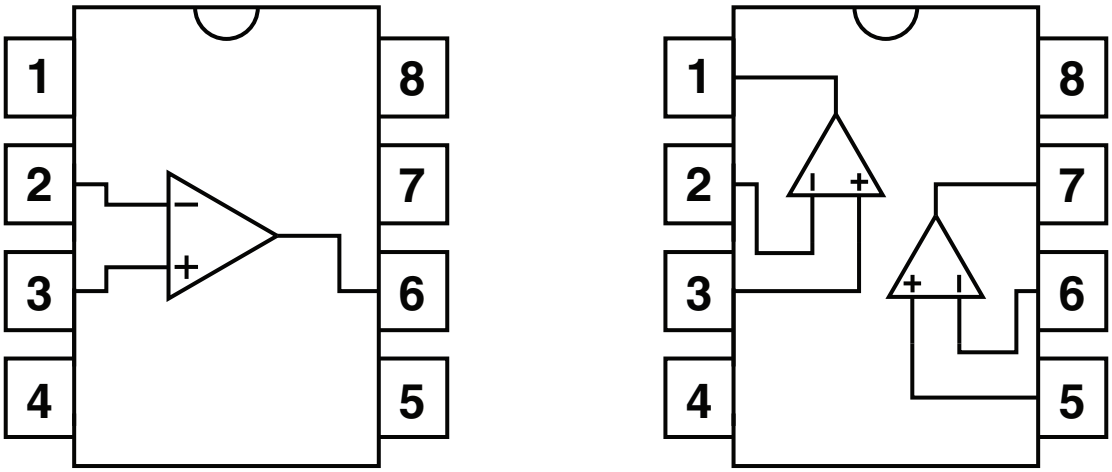
Fig. 10

(i) Tick the TWO true statements describing a comparator circuit.

If the + input is greater than the – input the output is high	☐
If the – input is greater than the + input the output is high	☐
If the + input is greater than the – input the output is low	☐
If the – input is greater than the + input the output is low	☐

[2]

(ii) It is found that a double comparator IC is available to replace the single version specified in Fig 10. Two versions of the IC are shown in Fig. 11.



CA 3140 **CA 3240**

Fig. 11

State <u>ONE</u> benefit, apart from cost, of using the double comparator IC.

_____

_____ **[1]**

(c) Fig. 12 shows a multi-turn preset resistor, needing 10 turns to cover the full range of resistance.

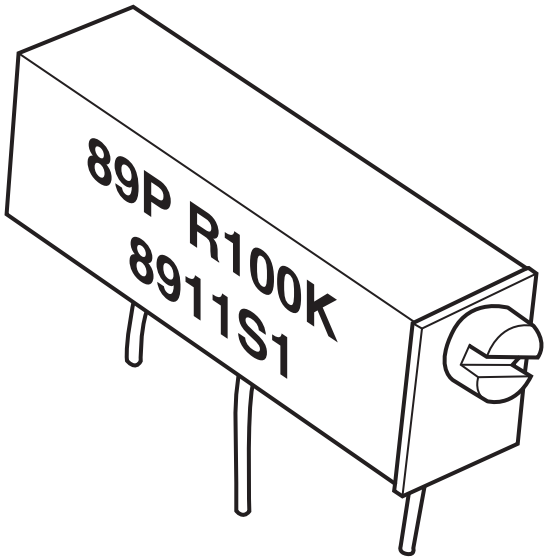


Fig. 12

State the reason for using the multi-turn preset resistors as VR1 and VR2 in Fig. 10.

_____

_____ **[1]**

(d) (i) When necessary the comparators will operate a cooling fan and a heater.
The cooling fan is rated at 12 V DC 7.9 W.
Calculate the maximum current flow in the cooling fan circuit.
Use the formula P = V × I.

_____

_____

_____ **[2]**

(ii) From the list below select the most suitable fuse to protect the cooling fan circuit.

250 mA 1 A 800 mA 630 mA 2.5 A

_____ **[1]**

[Total: 10]

4 (a) A kitchen timer circuit is based on a 4017B decade counter IC.
The count advances on a clock pulse occurring once every minute.
The IC counts from 0–9 before automatically resetting to 0.
A breadboard layout shown in Fig. 13 (opposite) is used to test that the IC is working.
A bargraph display with ten LEDs is used on the breadboard.

(i) Add the VSS and VDD connections to the breadboard. [2]

(ii) The clock arrangement used for testing the circuit consists of a pull up resistor and a flying lead.
Describe the problem with using this arrangement for testing the IC.

_____

_____

_____ **[1]**

(iii) State the maximum time that will be counted by the circuit if the reset connection is moved to output 7 (pin 6).

_____ **[1]**

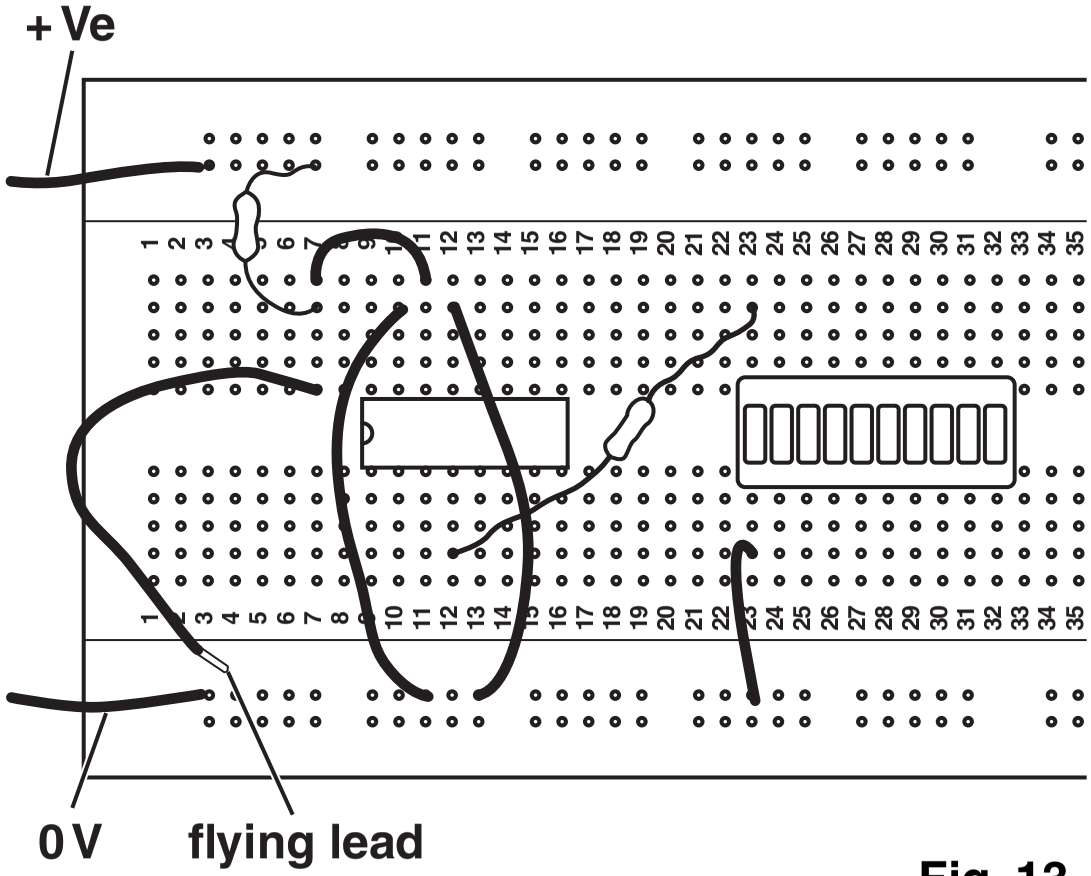
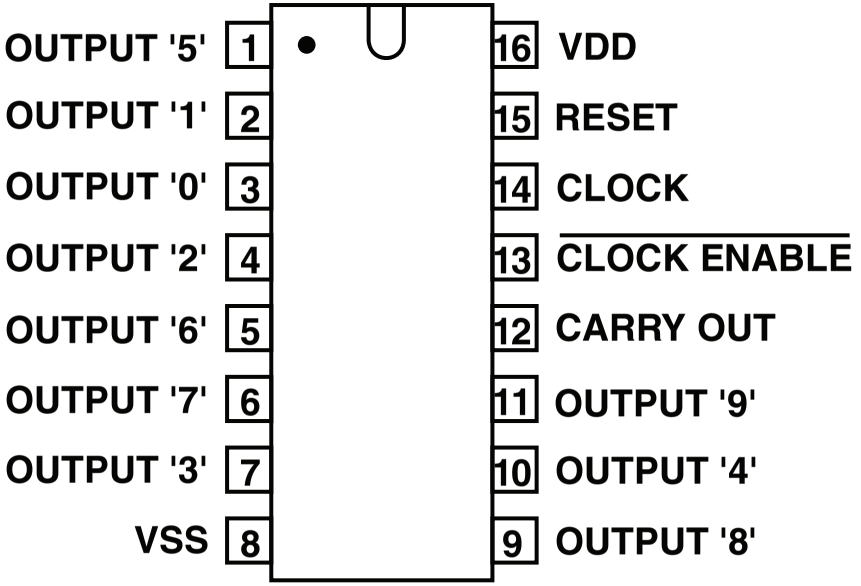


Fig. 13

4017B Decade Counter



(b) The output of the circuit is to be connected to a separate display board using a ribbon cable and connector as shown in Fig. 14.

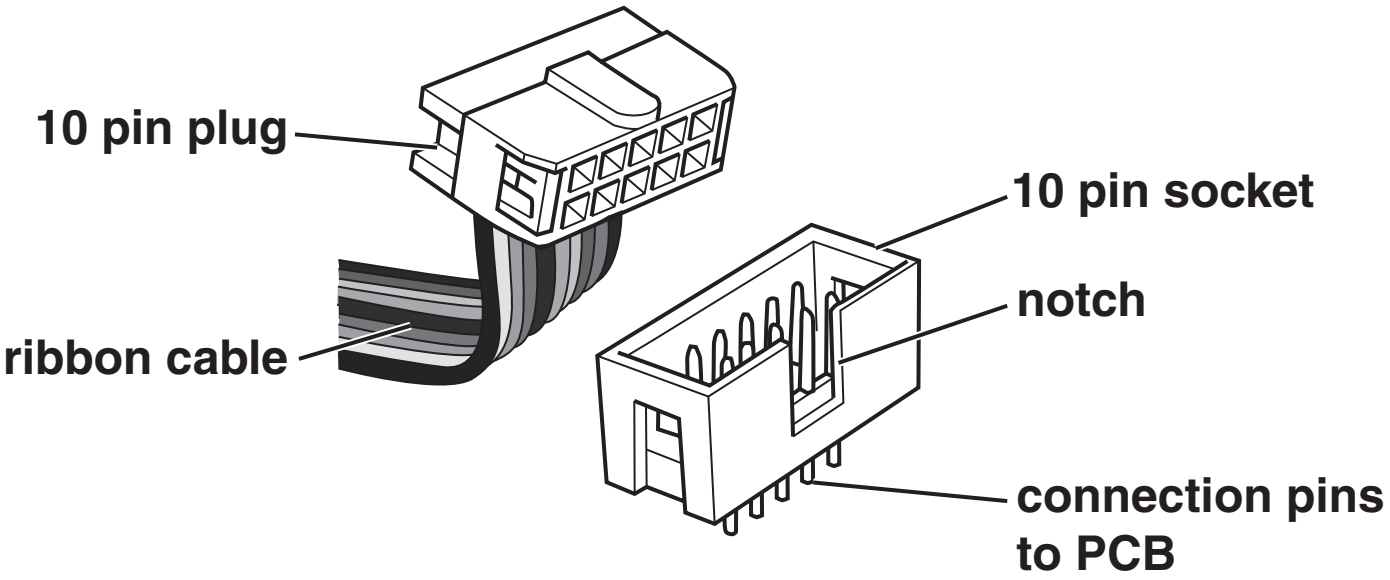


Fig. 14

(i) Give <u>ONE</u> benefit of using ribbon cable with a plug and socket system to connect two circuit boards together.

_____

_____ **[1]**

(ii) A notch is visible in the case of the 10 pin socket.
State the purpose of the notch.

_____

_____ **[1]**

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(c) Part of the PCB layout for the circuit is shown in Fig. 15.

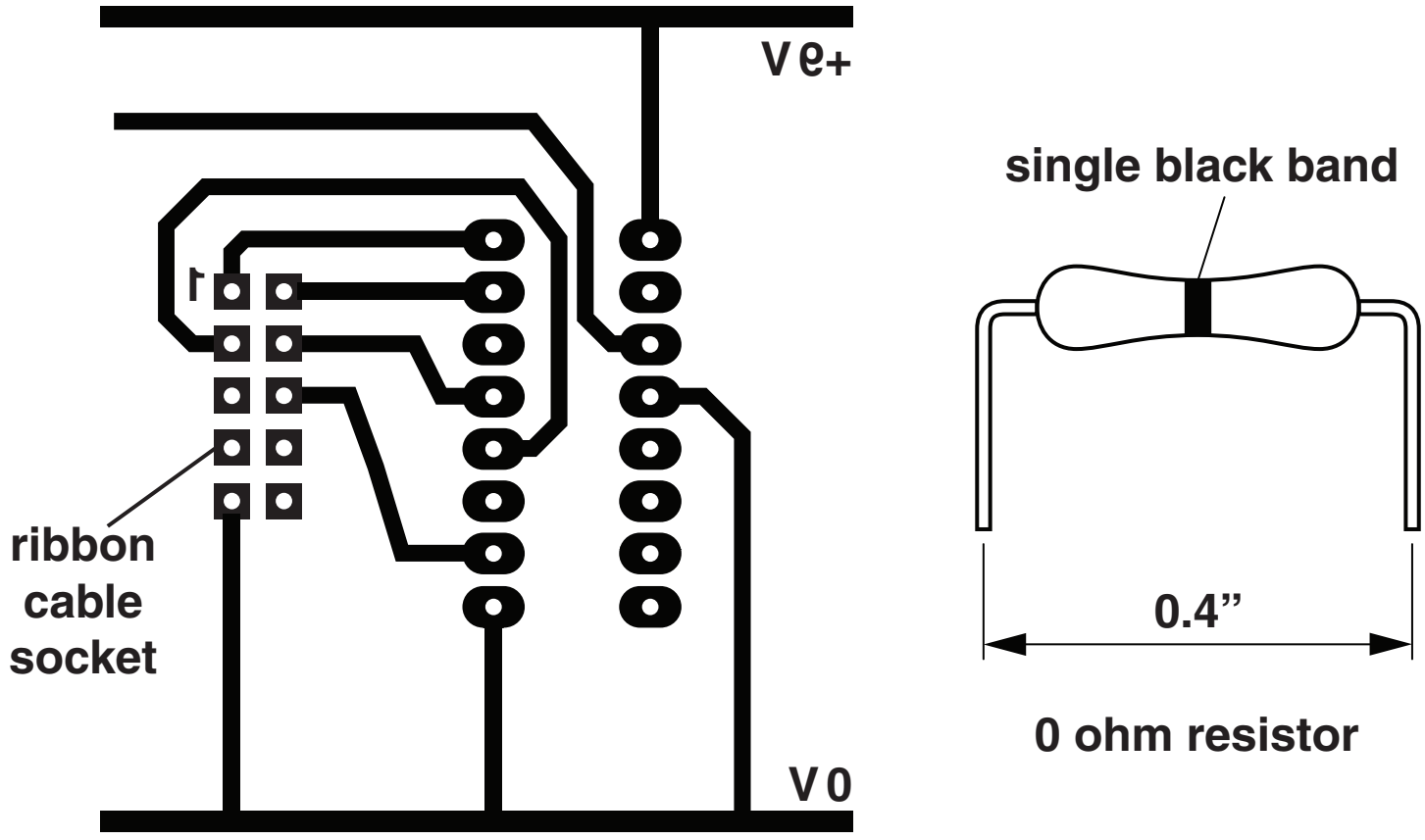

Fig. 15

(i) Add the following <u>TWO</u> connections using a 0 ohm resistor to form a link if necessary. Tracks must not be taken through the narrow gaps between pads.

<u>PIN 6 ON THE RIBBON CABLE SOCKET TO OUTPUT 4 (PIN 10) ON THE IC.</u>
<u>RESET CONNECTION TO OUTPUT 7 (PIN 6).</u> [2]

(ii) Explain how the use of 0 ohm resistors rather than a link wire could assist with batch production.

_____

_____

_____

_____ **[2]**

[Total: 10]

5 In a quiz competition the first of two teams to press their switch can answer the question. A logic system is used to decide which team pressed first.

(a) (i) Complete Fig. 16 to show a switch arrangement that will produce a logic 1 signal at point X when the switch is pressed and a logic 0 signal when it is released.

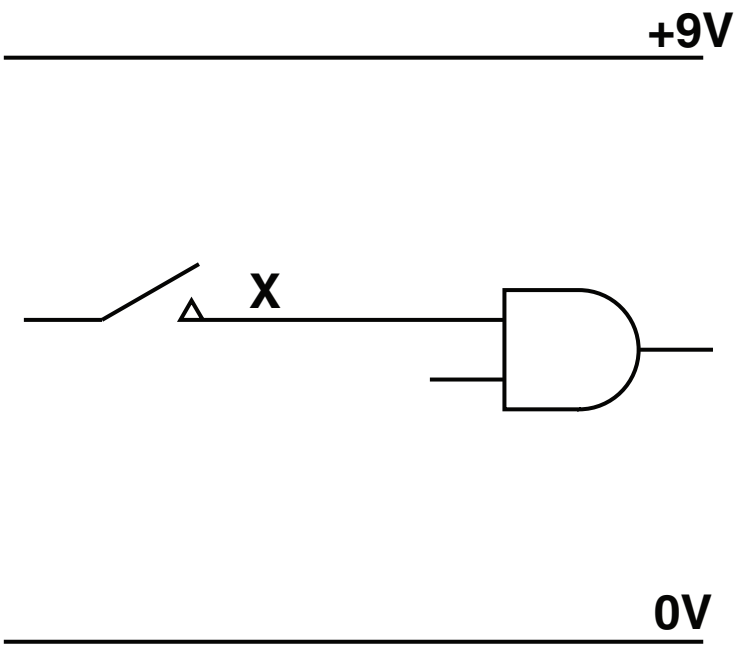

Fig. 16 **[1]**

(ii) **Fig. 17 shows part of the circuit diagram for the system.**

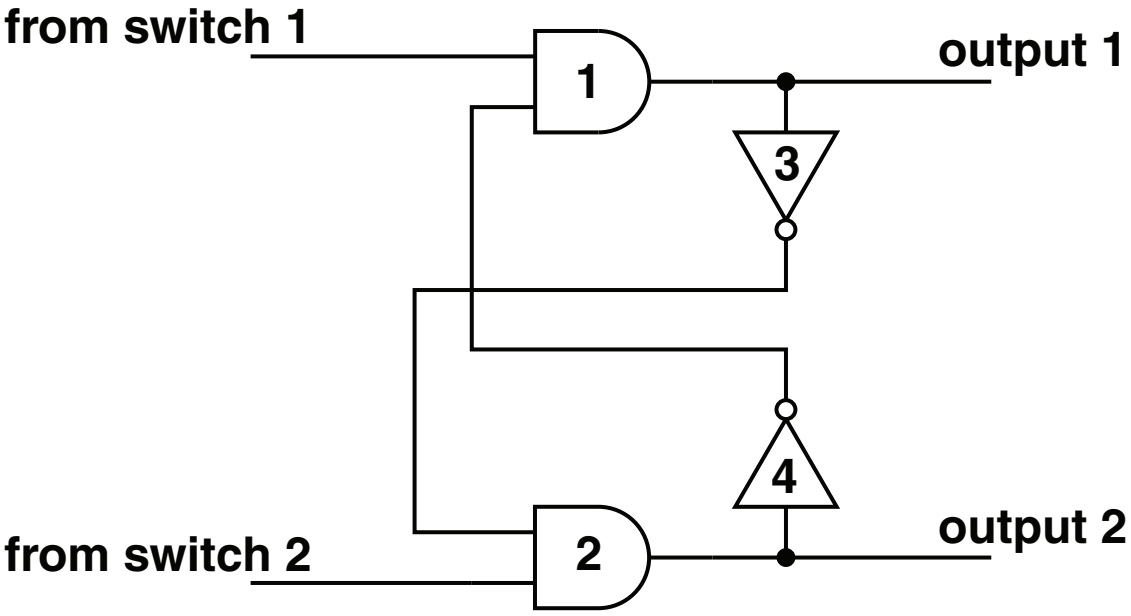

Fig. 17

Gates 3 and 4 connect the inverted output from an AND gate to an input of the other AND gate.
Describe the result of this connection from inverter to AND gate input.

_____

_____

_____ **[1]**

(b) Complete Fig. 18 to show the logic levels of each gate when SW2 is pressed first.

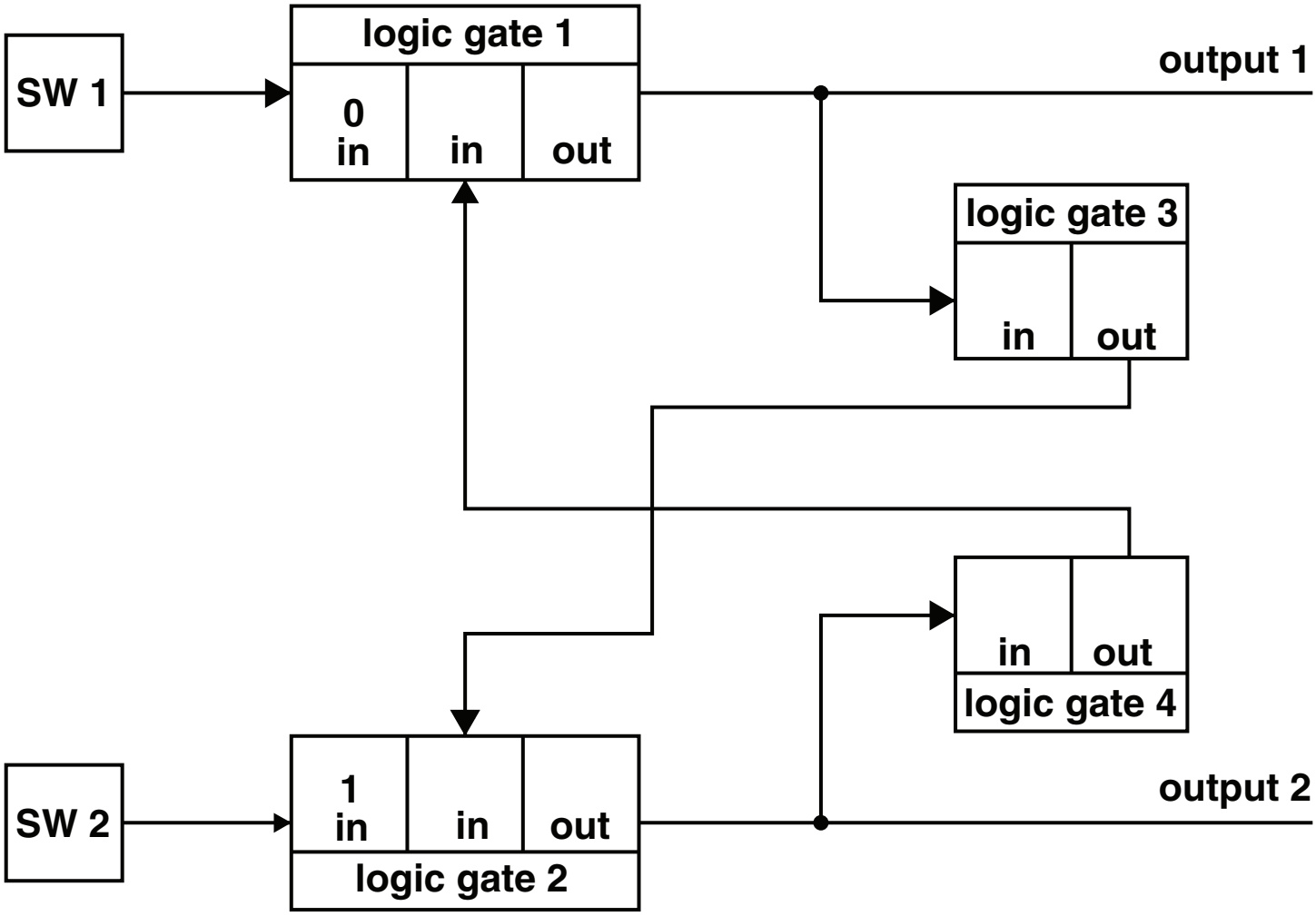

Fig. 18 [4]

(c) On Fig. 19 add a suitable logic gate and complete the connections to show how either output can operate the buzzer.

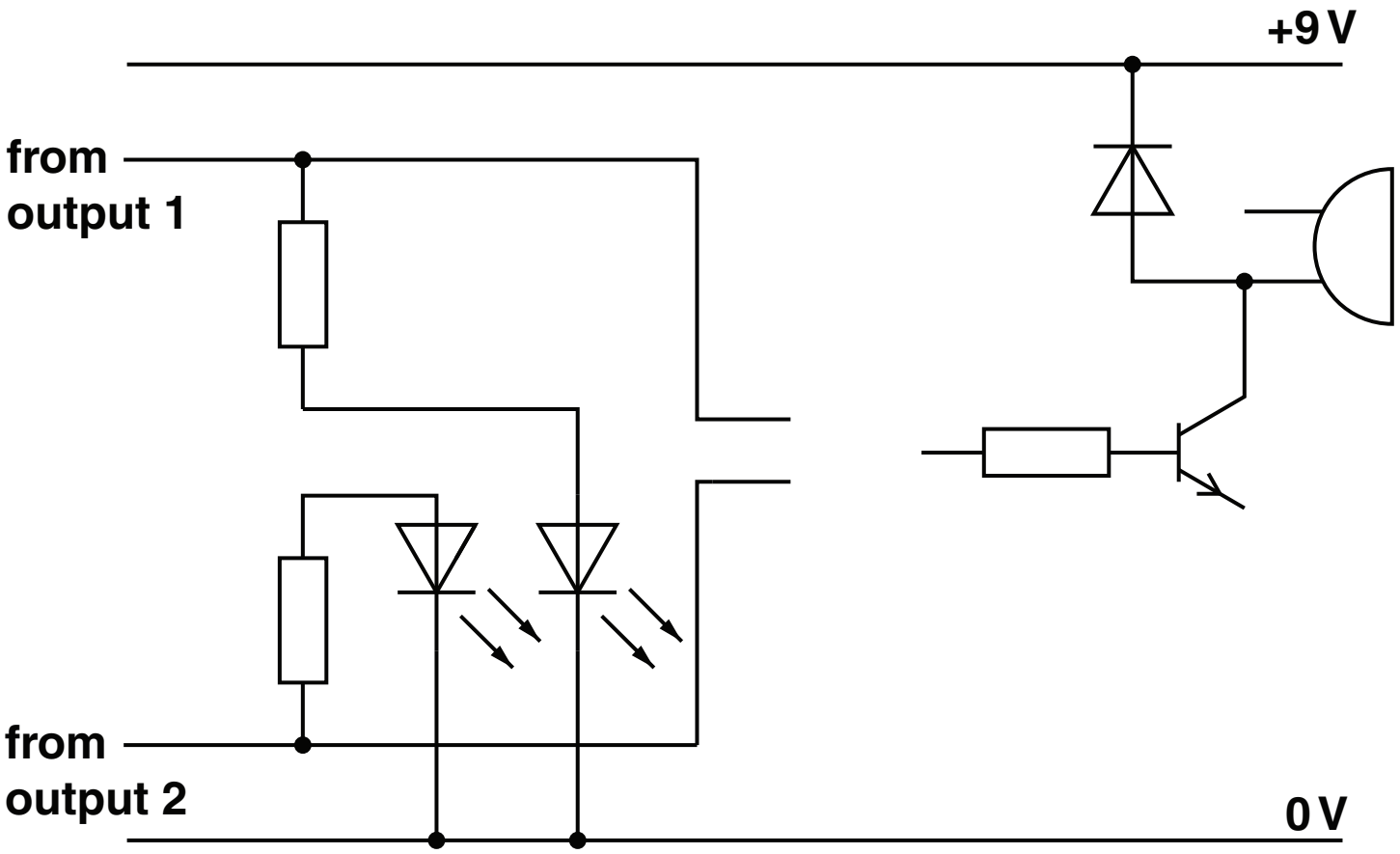

Fig. 19 [2]

(d) A PIC circuit could be an alternative method to the use of logic gates.
Explain how the two circuits could be evaluated to find the most suitable.

_____

_____

_____

_____ [2]

[Total: 10]

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