OCR
RECOGNISING ACHIEVEMENT

GENERAL CERTIFICATE OF SECONDARY EDUCATION

DESIGN AND TECHNOLOGY

A514/01

Electronics and Control Systems

Technical Aspects of Designing and Making Electronics

Candidates answer on the question paper.

OCR supplied materials:
None

Other materials required:
- A calculator may be used

Tuesday 25 January 2011
Morning

Duration: 1 hour 15 minutes

OCE/27515

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- 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 your working out for calculations.
- Answer **all** the questions **in Section A and Section B**.
- Do **not** write in the bar codes.

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 **60**.
- Marks will be awarded for the use of correct conventions.
- Your quality of written communication is assessed in questions marked with an asterisk (*****).
- Dimensions are in millimetres unless stated otherwise.
- This document consists of **16** pages. Any blank pages are indicated.

A calculator may be used for this paper

Section A

Answer **all** questions.

1 **(a)** Soldering wires to LED legs is a job that often needs doing when constructing electronic products.
A soldered joint with wire and leg side by side is shown in Fig. 1.

Fig. 1

(i) The following equipment wire is available to connect to the LED cathode:

- yellow 1/0.6 mm
- black 7/0.2 mm
- black 1/0.6 mm
- red 7/0.2 mm.

State the most suitable wire to use.

..... **[1]**

(ii) Give **one** reason for your choice of wire.

..... **[1]**

(b) The quality of an electronic product can be improved by the use of materials such as heat shrink sleeving on soldered joints.
Fig. 2 shows an LED with heat shrink sleeving in place.

Fig. 2

(i) State **two** benefits of using heat shrink sleeving on a joint.

Benefit 1 .....

Benefit 2 ..... **[2]**

(ii) The heat shrinking can be carried out with the cooler part of a soldering iron tip as shown in Fig. 3.

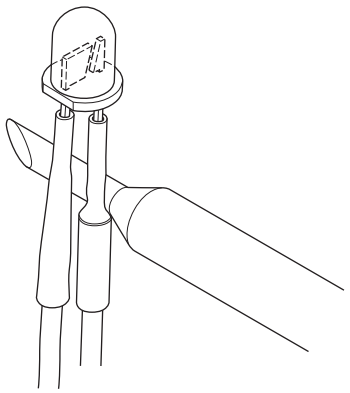

Fig. 3

In this process there is a danger of burns from the soldering iron.
Describe the procedure that should be followed if a burn from a soldering iron occurs in a school workshop.

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..... **[2]**

(iii) The stages in soldering a wire to an LED leg are given below.
Use the stages in the correct order to complete the block diagram.
The first stage has been completed.

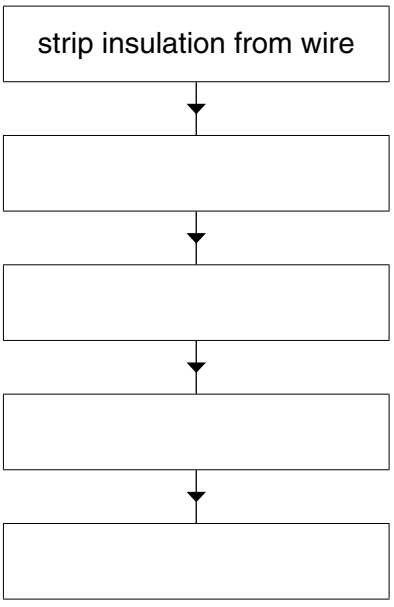
tin the wire and LED leg

heat joint to melt solder

strip insulation from wire

place wire next to LED leg

place heat shrink sleeving over wire



[2]

(c) Fig. 4 shows screw terminals that will be used to attach the LED wires to the circuit board.

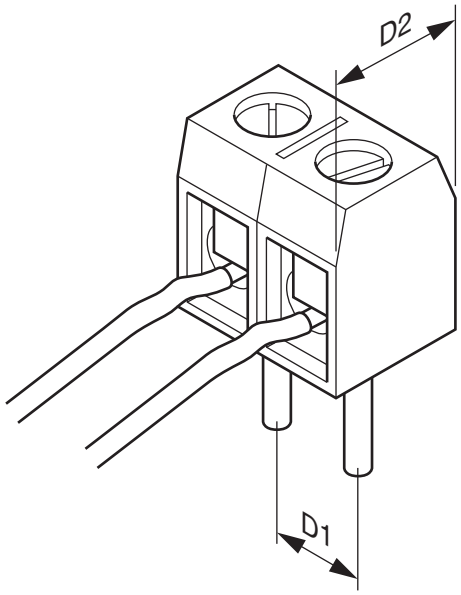


Fig. 4

(i) Explain why the dimensions, **D1** and **D2**, marked on the screw terminal drawing are important to the PCB designer.

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..... **[2]**

(ii) When the LED wires are connected to the screw terminals a quality control check should be carried out to ensure that the connection is good.
Describe **two** visual checks that should be carried out when looking at the quality of the connection.

Check 1 .....

.....

Check 2 .....

..... **[2]**

[Total: 12]

2 A system to count the number of birds entering a nesting box is shown in Fig. 5.
The system uses a counter IC and a decoder IC to drive a seven segment LED display.

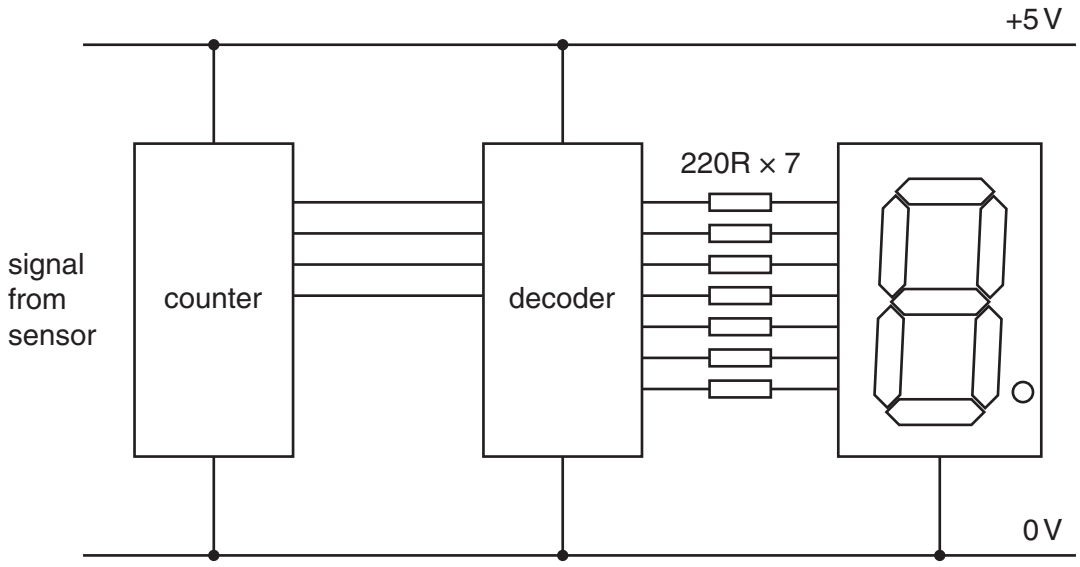

Fig. 5

(a) When displaying numbers either LED or LCD displays can be used.

(i) Give **one** benefit for each type of display.

Benefit of LED display .....

Benefit of LCD display ..... **[2]**

(ii) The counter IC is a single digit binary coded decimal (BCD) counter.
State the highest number in decimal that can be counted by a single counter IC.

..... **[1]**

(b) The maximum count may need to be increased for the final nesting box counter circuit.
Give **one** reason for the increase.

..... **[1]**

(c) An improved version of the output part of the circuit is shown in Fig. 6.

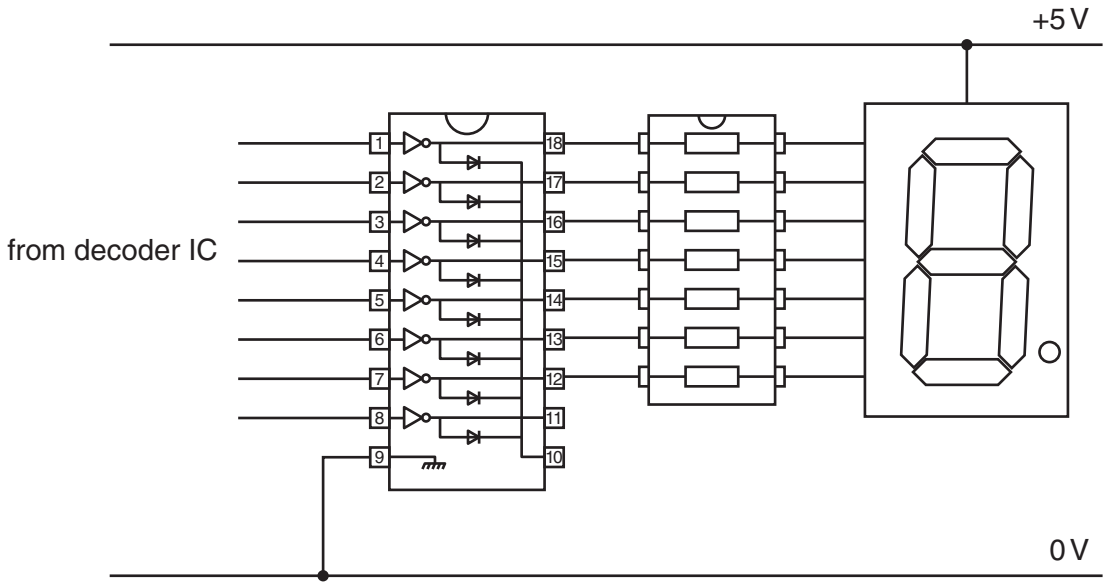

Fig. 6

(i) The resistors shown in Fig. 6 are in a DIL resistor network.
Give **one** benefit of using a resistor network rather than separate resistors.

..... **[1]**

(ii) Explain why adding a Darlington driver IC means that the seven segment display has to be changed from common cathode to common anode.

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..... **[2]**

(iii) Details of the display to be used are shown in Fig. 7.
There is no pin diagram available to help with designing the final circuit.

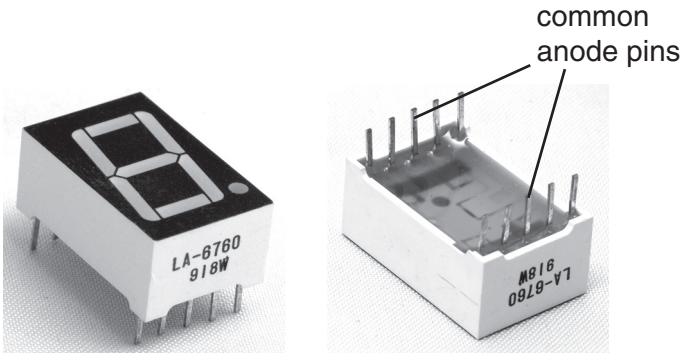

Fig. 7

The two available common anode pins are found by using a multimeter to take resistance readings.
State the resistance that could be expected between these two pins.

..... **[1]**

(iv) Describe how the pins for each segment can be identified once the common anode pins have been identified.

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..... **[2]**

(d) The sensor used to operate the counter will be an infra red reflective type as shown in Fig. 8.

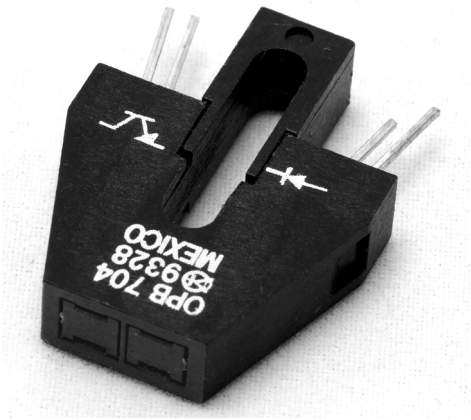

Fig. 8

Explain why a sensor using infra red light has been chosen.

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[Total: 12]

3 Fig. 9 shows a solar powered garden light with details of the circuit.

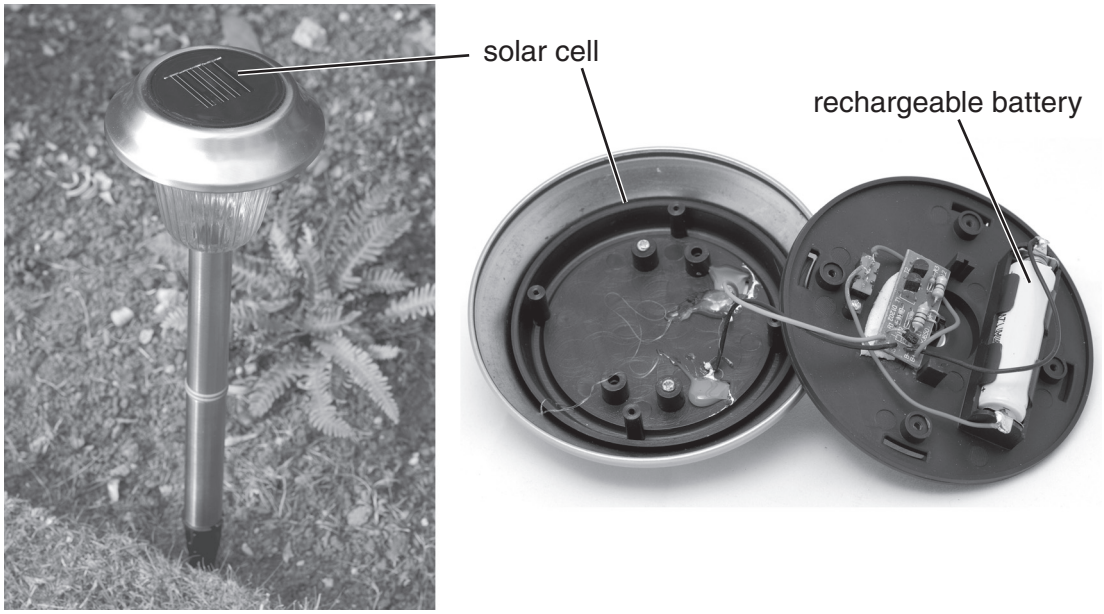

Fig. 9

(a) The solar cell provides 1.4 V from sunlight, which is used to charge the 1.2 V 600 mAh NiMH battery.
The light switches on automatically at dusk but does not use an LDR, photodiode or phototransistor to detect light level.

Explain how the circuit can sense that it is dark enough to switch the LED on.

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..... **[2]**

(b) When the current flow is measured at dusk with the LED lit, it is 12 mA.
The current measurement later in the evening has fallen to 8 mA.
Give **one** possible reason for this.

..... **[1]**

(c) Fig. 10 shows the LED cover and the clear cover for the garden light.
Both use a bayonet type fitting which locks when turned clockwise.

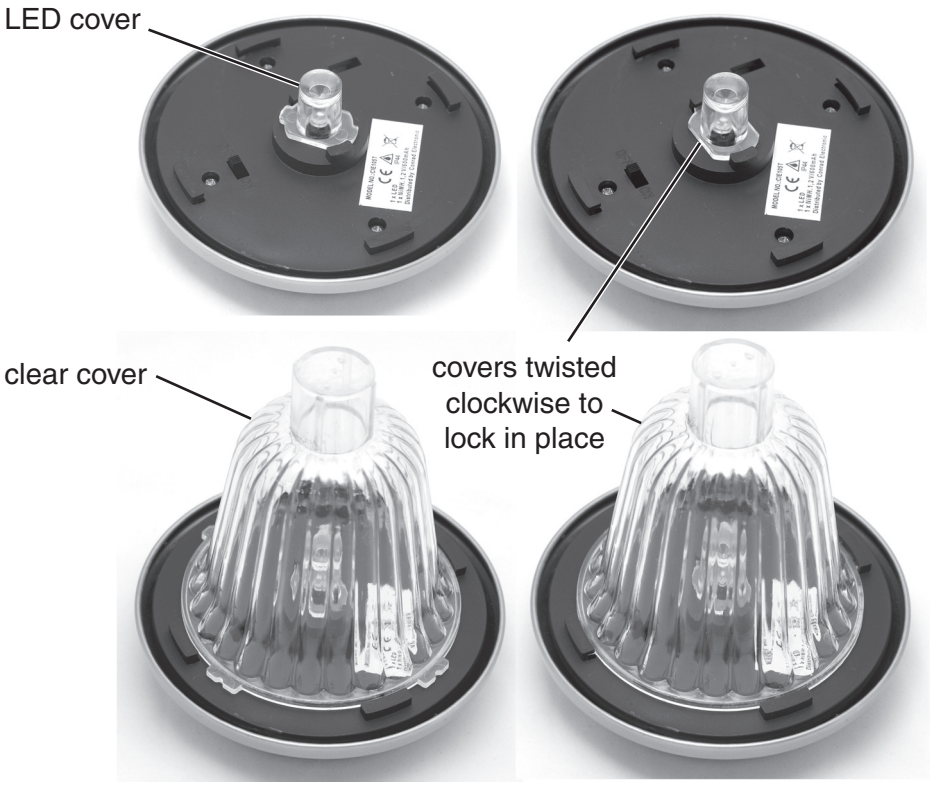

Fig. 10

(i) Give **two** possible reasons for using a bayonet fitting.

Reason 1 .....

Reason 2 ..... **[2]**

(ii) Give **one** ergonomic reason for the use of a clockwise movement for locking the fittings.

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..... **[1]**

(d*) Discuss the benefits and drawbacks of using solar power as a power source in electronic products.

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..... **[6]**

[Total: 12]

Section B

Answer **all** questions.

4 Part of a circuit being developed to operate a solenoid is shown in Fig. 11.

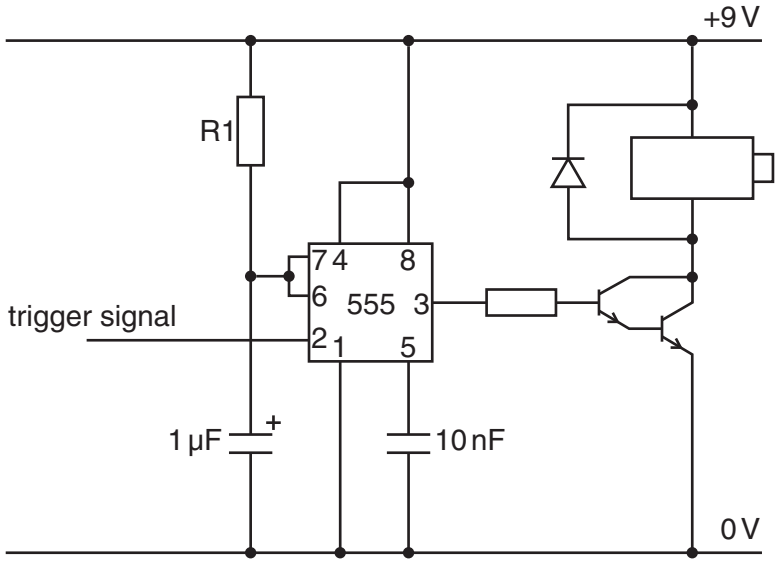

Fig. 11

(a) The solenoid is a latching type which requires a short monostable pulse to remain pulled in and another short monostable pulse to release.
State the advantage that this type of solenoid has over a solenoid that has to be constantly powered when pulled in.

..... **[1]**

(b) The specification for the solenoid gives the minimum pulse length as 40 ms.
It is decided to design the circuit to have a pulse length of 60 ms.
Give the reason for slightly extending the length of pulse.

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..... **[1]**

(c) **(i)** Timing components for the monostable circuit are shown in Fig. 11.
Calculate the value of R1 that is needed to produce a 60 ms pulse.
The value of the timing capacitor is 1 µF.

Use the formula $t = 1.1 \times R1 \times C1$.

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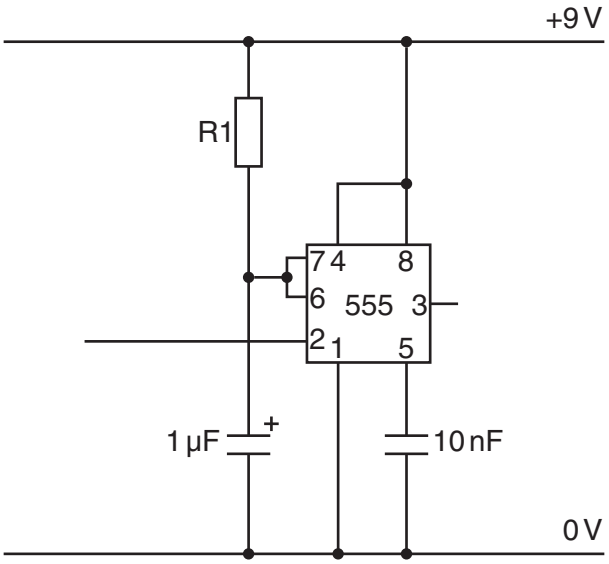
..... **[2]**

(ii) To allow adjustment a preset variable resistor is used.
From the range shown below circle the most suitable value.

470 K **5 K** **1 M** **100 K** **10 K**

..... **[1]**

(iii) The monostable trigger signal is a negative or falling edge at pin 2.
Add to Fig. 12 a 10 K resistor and push to make switch to provide a trigger signal.



[2]

Fig. 12

(iv) State the problem that occurs if the switch remains pressed.

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..... **[1]**

(d) Fig. 13a shows an improved trigger that provides a signal shorter than the output pulse. Draw the 60 ms output pulse on the graph in Fig. 13b.

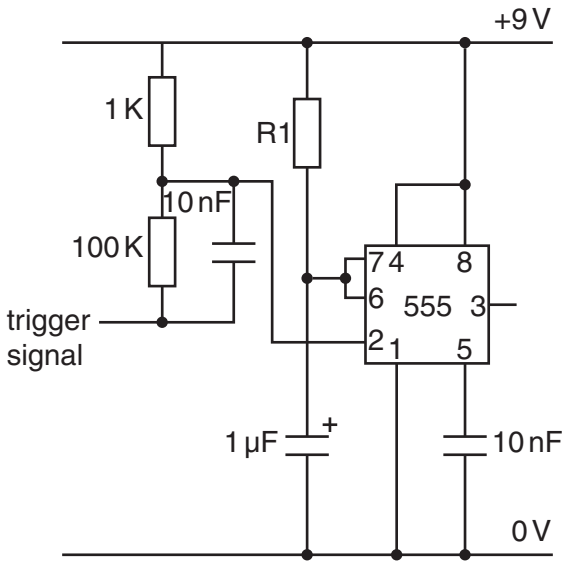

Fig. 13a

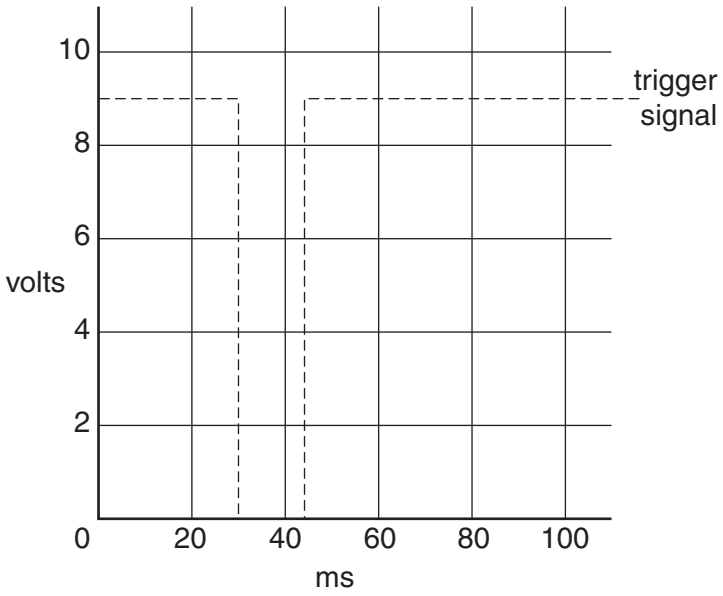

Fig. 13b

[2]

(e) Checking that a short output pulse is operating correctly can be difficult.
One solution is to use the output pulse to trigger an RS bistable as shown in Fig. 14.

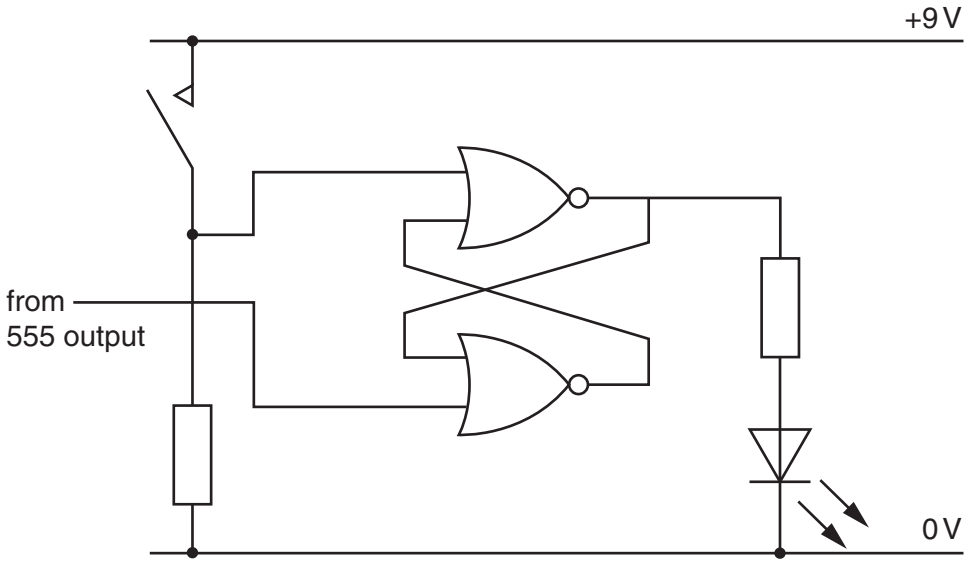

Fig. 14

Describe how this circuit allows the monostable output to be tested.

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..... **[2]**

[Total: 12]

5 Fig. 15 shows part of a circuit diagram for a driver circuit to operate a small dc motor.
Next to the circuit diagram is the PCB layout for the circuit with some connections missing.

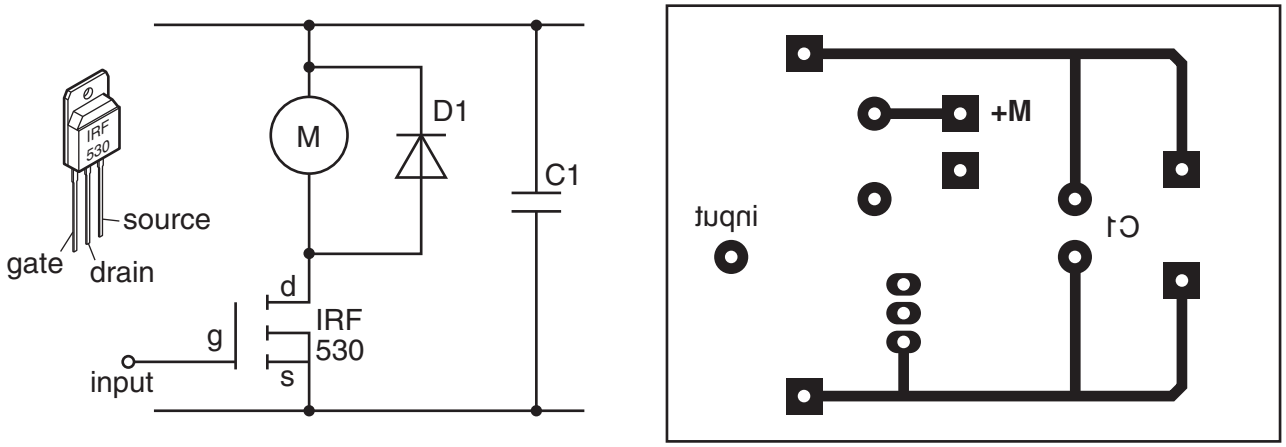
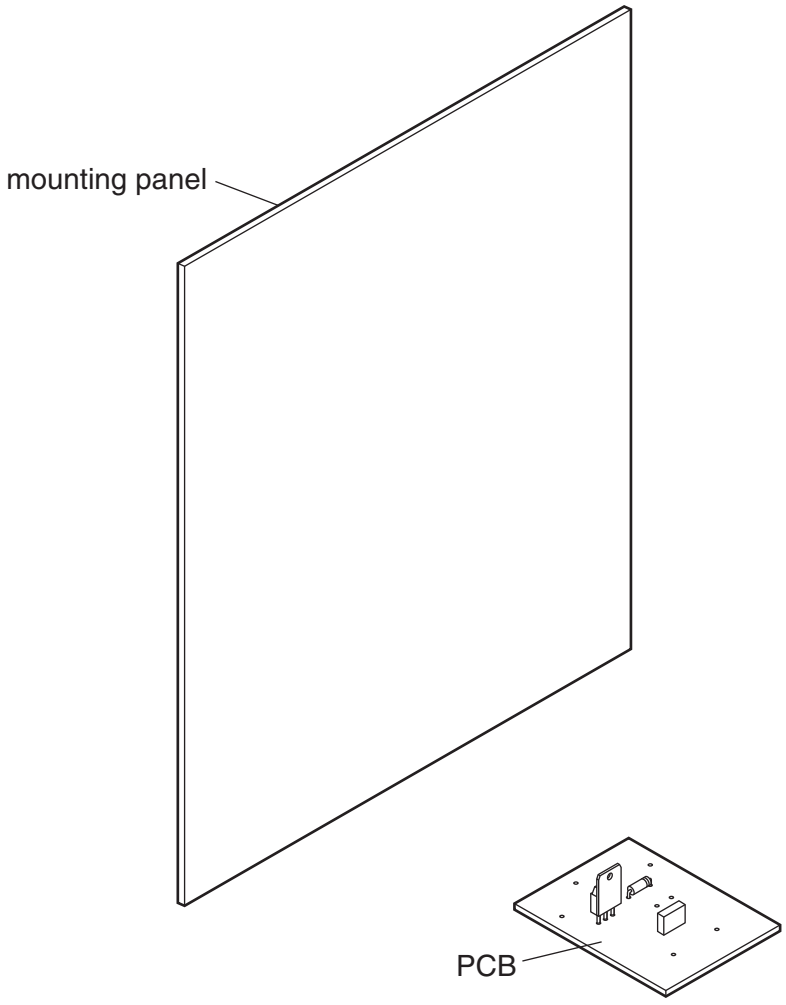


Fig. 15

(a) Complete the connections on the PCB layout. **[3]**

(b) The outline of the PCB and the panel that it is to be fitted to are shown in Fig. 16.
Use sketches and notes to show a method of holding the PCB in position on the panel.
It must be possible to remove the PCB for testing or repair.



[3]

Fig. 16

(c*) PCBs can be produced by the photoetch method which removes unwanted copper from the board or by newer processes such as printing using conductive inks.
Discuss the benefits of each method.

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[Total: 12]

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