



GENERAL CERTIFICATE OF SECONDARY EDUCATION
DESIGN AND TECHNOLOGY
ELECTRONICS AND CONTROL SYSTEMS

A514/01

Technical aspects of designing and making
 Electronics

Tuesday 22 June 2010
Morning

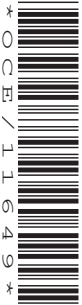
Duration: 1 hour 15 minutes

Candidates answer on the Question Paper

OCR Supplied Materials:
 None

Other Materials Required:

- A calculator may be used



Candidate Forename		Candidate Surname	
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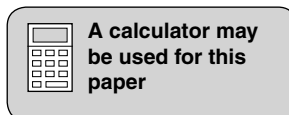
Centre Number						Candidate Number				
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INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- 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.
- Do **not** write in the bar codes.
- 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.

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.



Section A

Answer **all** questions.

- 1 Fig. 1 shows two views of a wind-up torch. The torch battery is charged when the charging handle is turned for a short time. Either the centre LED or all three LEDs together can be switched on.

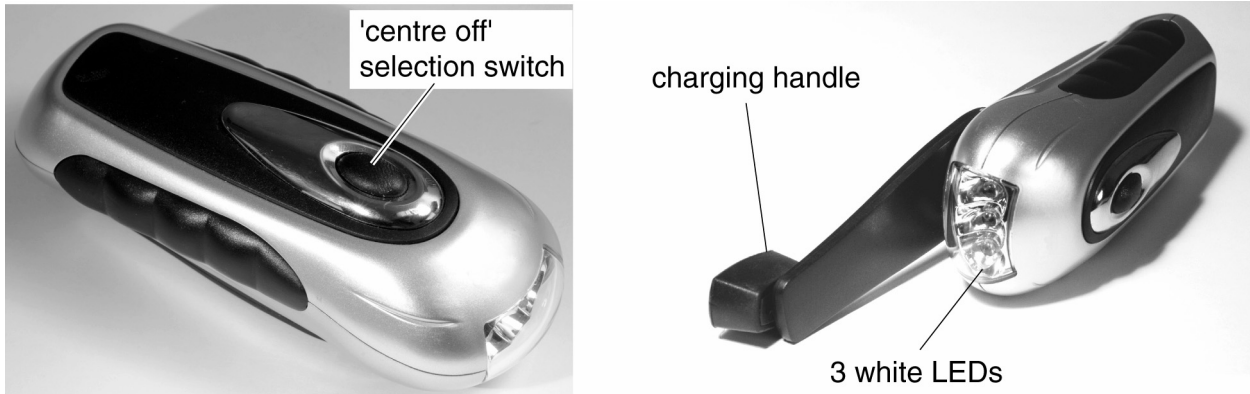


Fig. 1

- (a) Give **one** ergonomic factor that has been considered in the design of the torch.

..... [1]

- (b) The selection switch operates in the following sequence:

off / LED 1 on / off / LEDs 1,2,3 on / off

Fig. 2a shows a possible switch circuit for the torch.

When tested it is found that all LEDs light in both of the on positions.

- (i) Complete Fig. 2b to show how a diode can be used to overcome the problem.

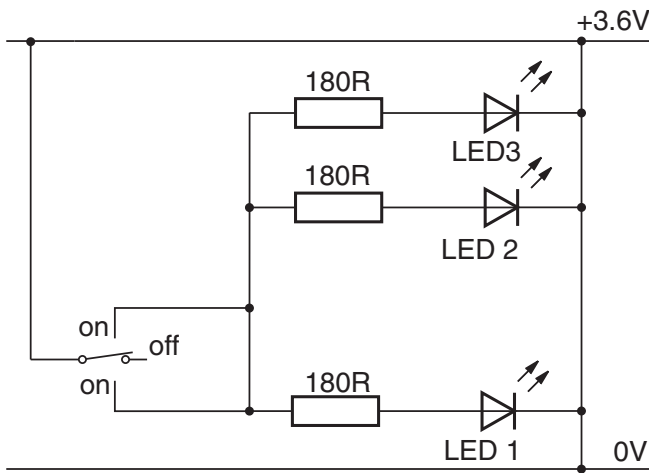


Fig. 2a

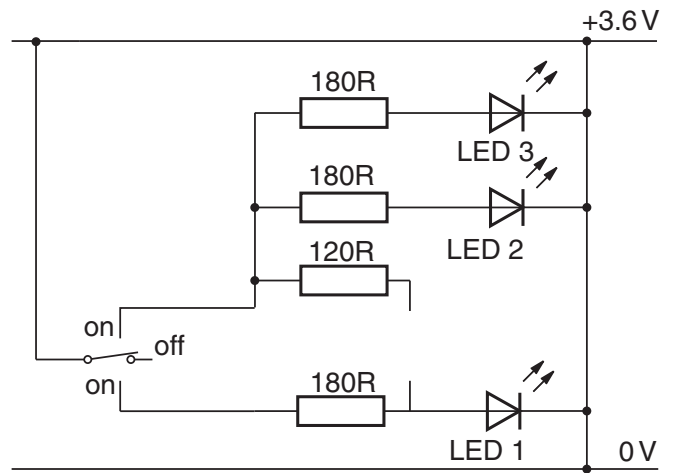


Fig. 2b

[2]

(ii) Explain why a 120R resistor is used for LED 1 when all three LEDs are on.

.....

.....

..... [2]

(iii) Fig. 3 shows a 180R 5% tolerance resistor. Using the table of resistor colours label the colour bands on the resistor. [2]

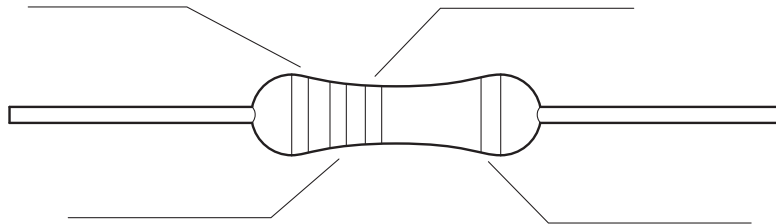


Fig. 3

Band 1 1st Digit	Band 2 2nd Digit	Band 3 No. of Zeros	Band 4 Tolerance
Black 0	Black 0	Black 0	Gold 5%
Brown 1	Brown 1	Brown 1	Red 2%
Red 2	Red 2	Red 2	Brown 1%
Orange 3	Orange 3	Orange 3	
Yellow 4	Yellow 4	Yellow 4	
Green 5	Green 5	Green 5	
Blue 6	Blue 6	Blue 6	
Violet 7	Violet 7		
Grey 8	Grey 8		
White 9	White 9		

(c) The circuit board for the torch is shown in Fig. 4.

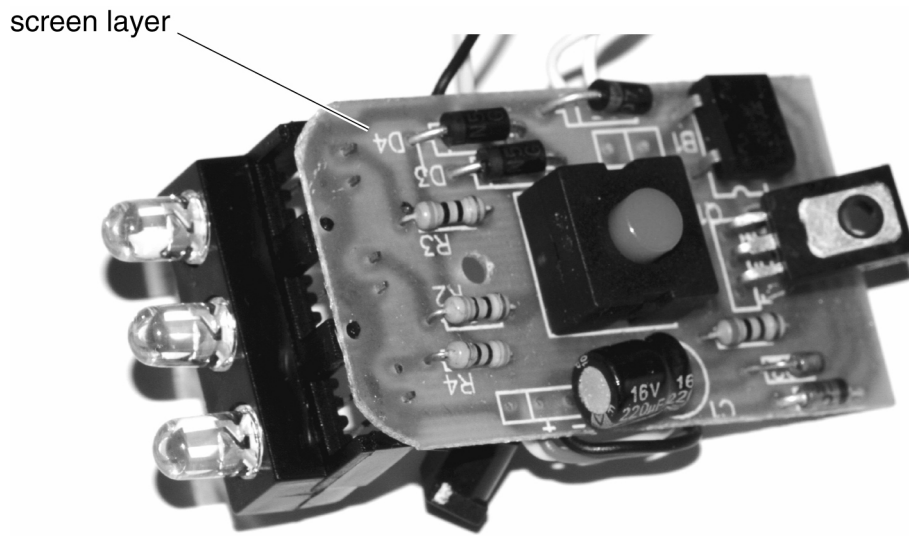


Fig. 4

Give **one** reason for printing a screen layer on the component side of the PCB.

..... [1]

(d) The rechargeable 3.6V 40mAh battery for the torch is shown in Fig. 5.

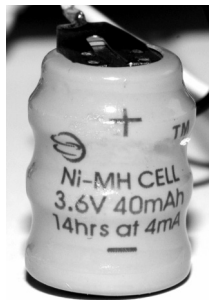


Fig. 5

Calculate the time that the single LED on the torch can light for when a fully charged battery is used.

There is a 1.8V drop across the LED and a 180 R protective resistor is used.

Use the formula $I = V/R$.

.....
.....
..... [3]

- (e) The charger for the torch uses a system of gears to rotate a dc motor shaft at high speed as shown in Fig. 6.
Turning the handle generates enough voltage to charge the battery.

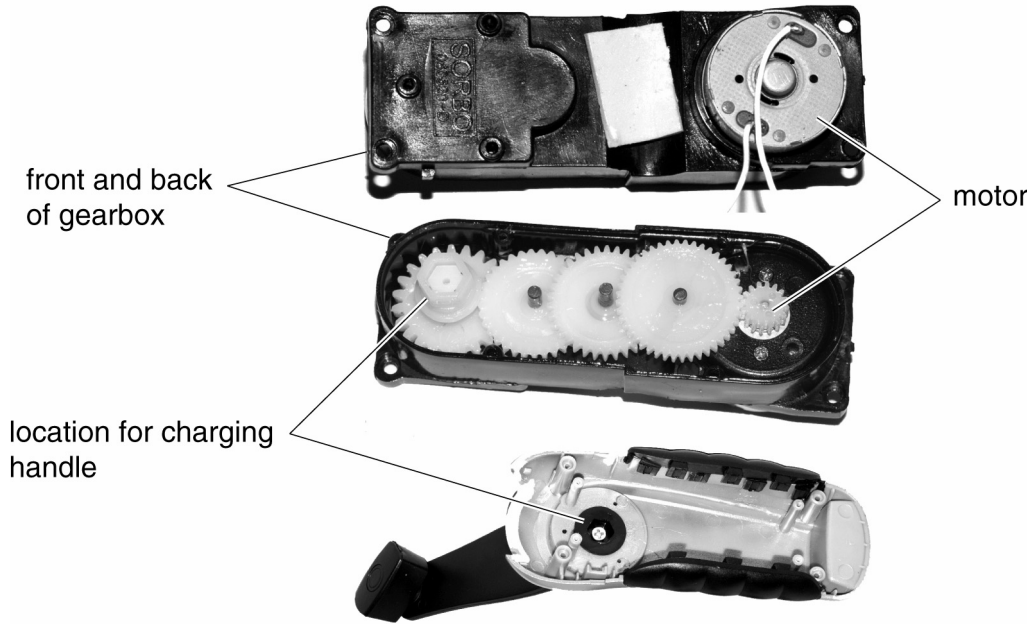


Fig. 6

Give **one** environmental benefit of using this system for a torch.

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

[Total: 12]

- 2 (a) Fig. 7 shows part of the circuit for a device to allow a cricket umpire to record the number of balls bowled in an over. The count is increased when SW1 is pressed.

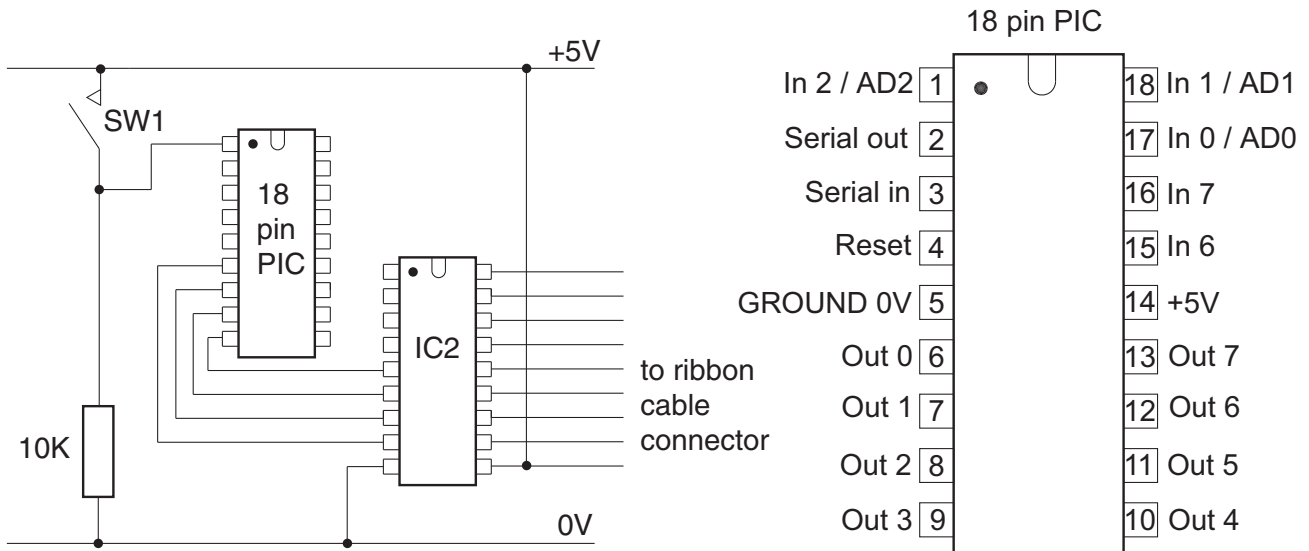


Fig. 7

- (i) Add the power connections to the PIC chip. [2]
- (ii) On Fig. 7 show the reset pin connected **high** through a 4K7 resistor and **low** through a switch. [2]
- (iii) IC2 is a Darlington driver array.
State the function of a Darlington driver array.
..... [1]

- (b) Fig. 8 shows a table giving information on the 7 segment display and the PIC output connections.

PIC output	pin value	display segment
0	1	a
1	2	b
2	4	c
3	8	d
4	16	e
5	32	f
6	64	g
7	128	

Fig. 8

- (i) State which segments will be lit to display number 3.
..... [1]

(ii) Give the total pin value that will be sent to the outputs to display number 3.

..... [1]

(c) The display PCB is connected to the main PCB using a ribbon cable as shown in Fig. 9.

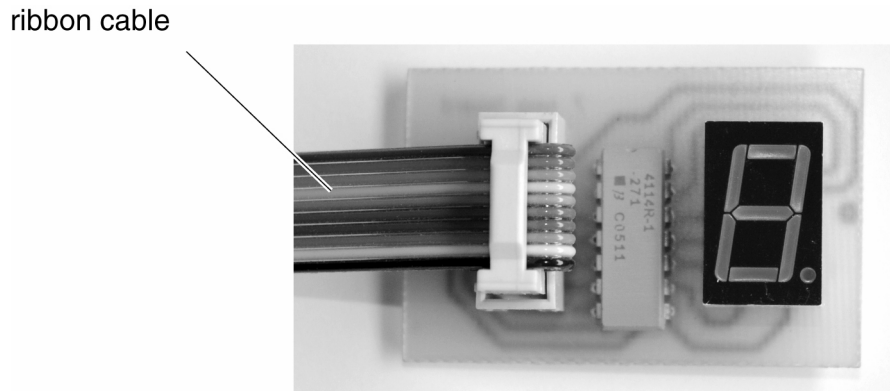


Fig. 9

Give **two** benefits of doing this rather than placing the display on the main circuit board.

Benefit 1..... [1]

Benefit 2..... [1]

(d) Fig. 10 shows the solder side of the display PCB with the resistor array ready for soldering.

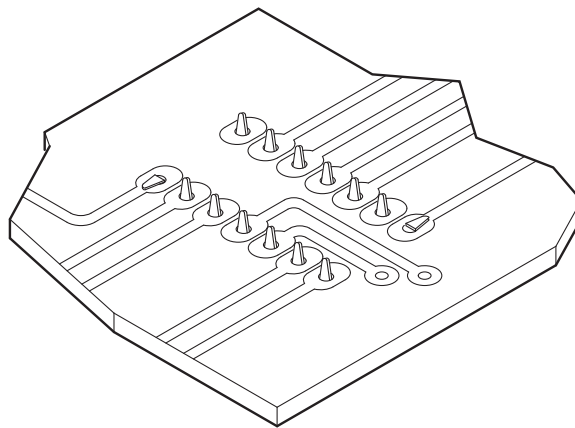


Fig. 10

Give **three** stages in the soldering process.

1..... [1]

2..... [1]

3..... [1]

[Total: 12]

3 Fig. 11 shows the circuit for a monostable timer for intervals up to five minutes.

(a) (i) Give the names of the **two** components that affect length of the time interval.

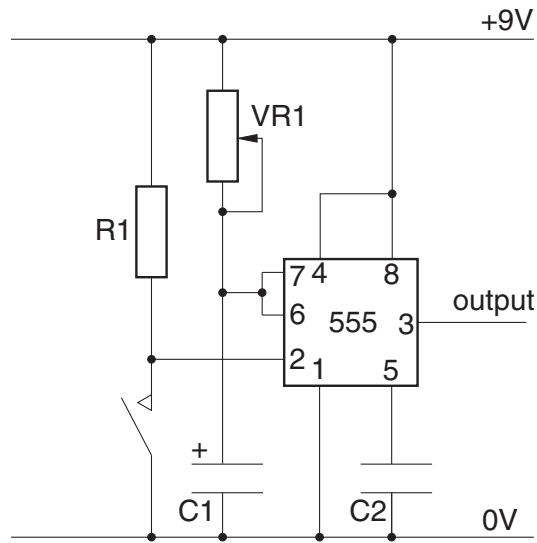


Fig. 11

component 1 [1]

component 2 [1]

(ii) The 555 timer is rarely used in industry for this type of delay circuit.

Give **two** reasons why programmable ICs have taken the place of the 555 timer.

1

..... [1]

2

..... [1]

(b) The output of the timer will be used to operate a buzzer with a current draw greater than is available from the 555 timer.

(i) Show on Fig. 12 how an NPN transistor can be connected to operate the buzzer.

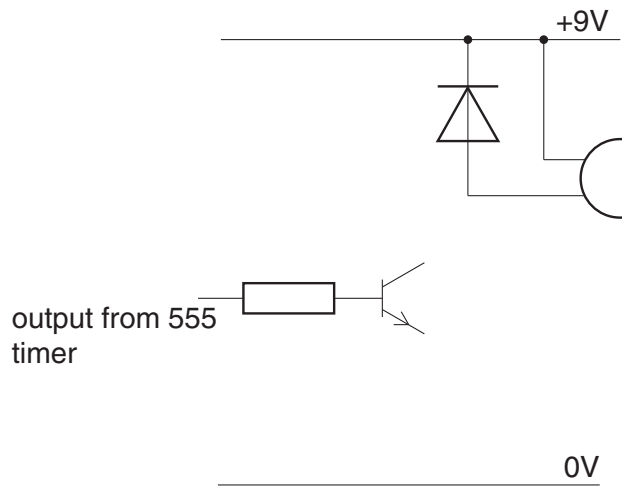


Fig. 12

[1]

(ii) Transistors can be tested using a multimeter to show the gain of the transistor. Fig. 13 shows a transistor being tested. Show the correct position of the setting dial for testing transistor gain.

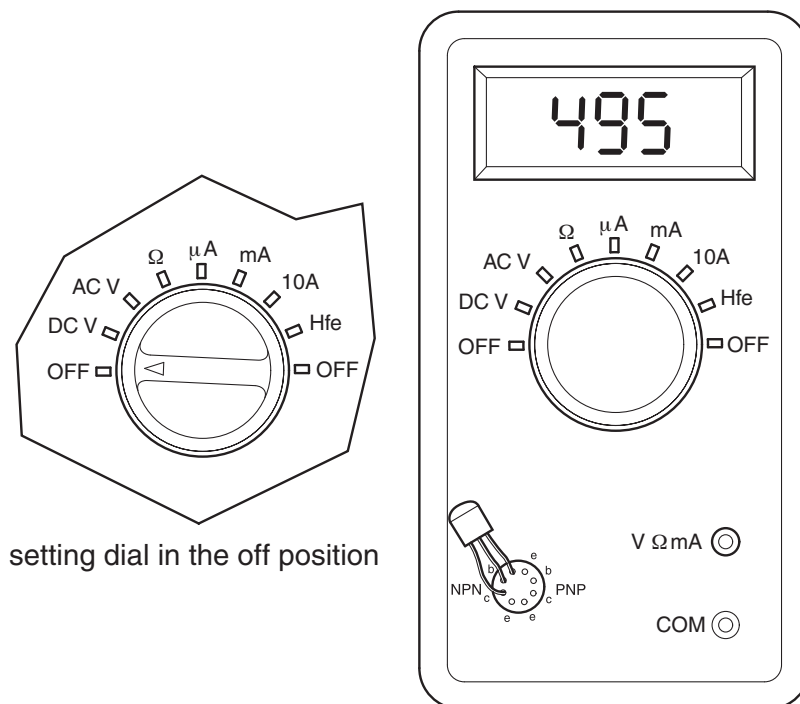


Fig. 13

[1]

Section B

Answer **all** questions.

4 (a) Fig. 14 shows part of the input circuit for a garage alarm system. The system is triggered by a pressure pad or a passive infra red (PIR) sensor.

- (i) Complete the input circuit by adding the following components to Fig. 14.
- a connection to NAND gate 1 to invert the pressure pad signal
 - both connections to NAND gate 2 to combine the inverted pressure pad signal and PIR signal.

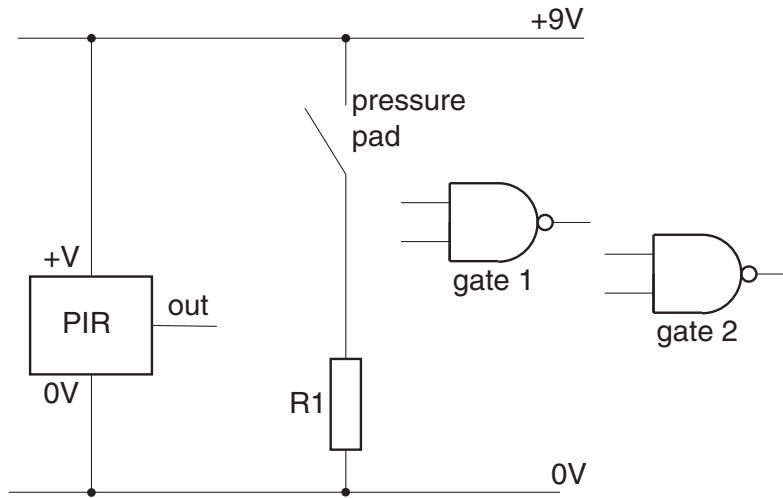


Fig. 14

[2]

(ii) Complete the truth table below.

	pressure pad	inverted signal (gate 1 output)	PIR sensor	combined signal (gate 2 output)
		0	0	1
		0	1	1
		1	0	1
		1	1	0

[1]

- (b) (i) Fig. 15 shows the start of the PCB layout for the latch section of the circuit. Add tracks to the PCB layout to connect R1 and SW1.

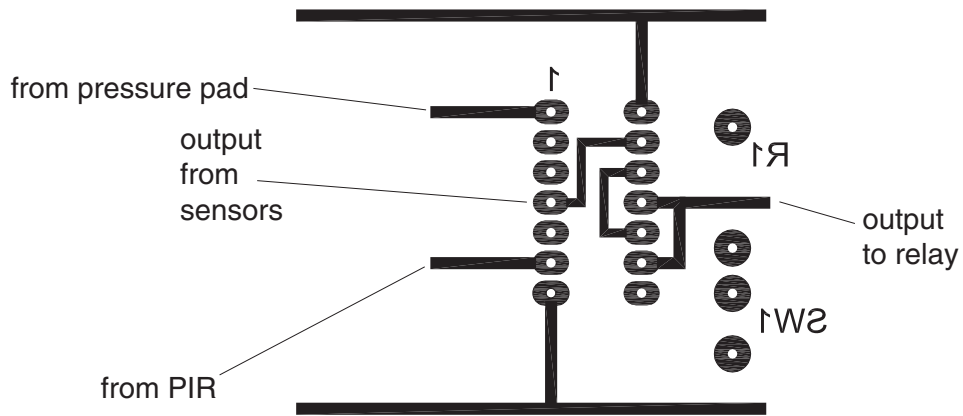
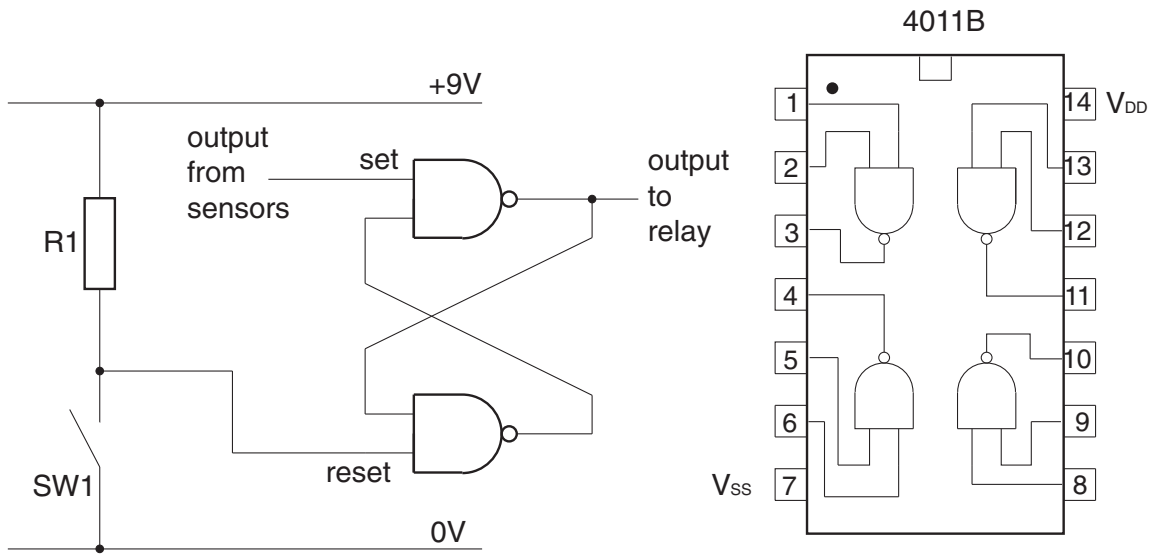


Fig. 15

[2]

- (ii) Give the reason for reversing the labels for pin 1, R1 and SW1.

..... [1]

- 5 (a) An automatic garden light which will switch on at dusk is being designed. Fig. 16 shows a test circuit that has been drawn using CAD simulation software.

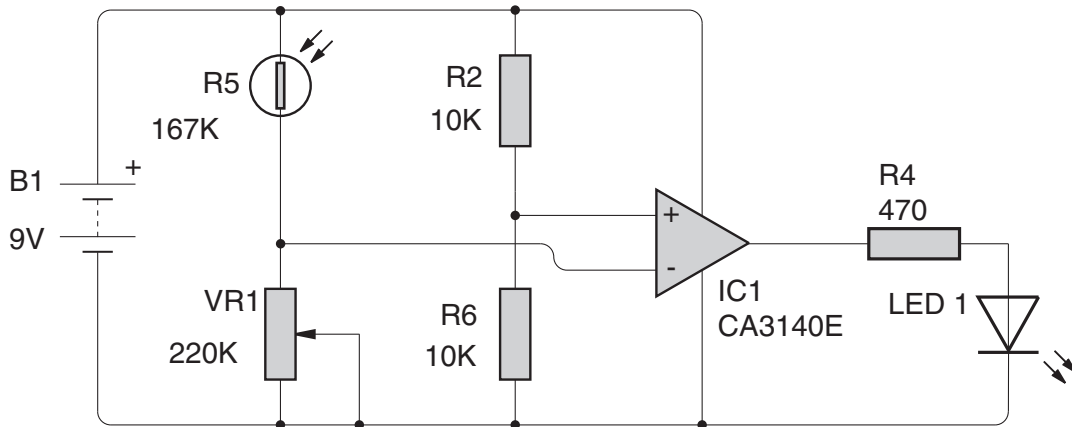


Fig. 16

- (i) Give **one** reason for using a potentiometer rather than a fixed resistor in series with the LDR.

..... [1]

- (ii) LED1 is used to check the output of the CA3140 comparator in the simulation. LED 1 may be left in the final circuit even though it will cost more to do so.

State the likely reason for leaving the LED in the final circuit.

..... [1]

- (iii) Explain why the LED is switched off.

Use the formula $V_{out} = \frac{R2}{R1 + R2} \times \text{supply voltage}$.

.....

 [3]

- (b) (i) The garden light will use a 12V 50W lamp which is switched on through a relay. Use the formula $P = I \times V$ to calculate the current flow in the lamp circuit.

.....
 [2]

- (ii) A protective fuse will be fitted to the lamp circuit. Choose the most suitable fuse from the values shown below.

5mA 10A 4A 4 μA 5A

..... [1]

(iii) Choose a suitable relay from the table shown below.

coil voltage	min coil voltage	contacts	max current	price	order code
5V	4	SPDT	3A	£ 0.98	RL-014
5V	4	DPDT	4A	£ 1.20	RL-016
12V	9	SPDT	4A	£ 1.50	RL-022
12V	9	DPDT	5A	£ 1.65	RL-024
12V	10	SPDT	5A	£ 1.50	RL-042

Order code for relay..... [1]

(c) Fig. 17 shows the casing that will be used for the sensing circuit. Use notes and sketches to describe how the printed circuit board can be fitted securely into the casing.

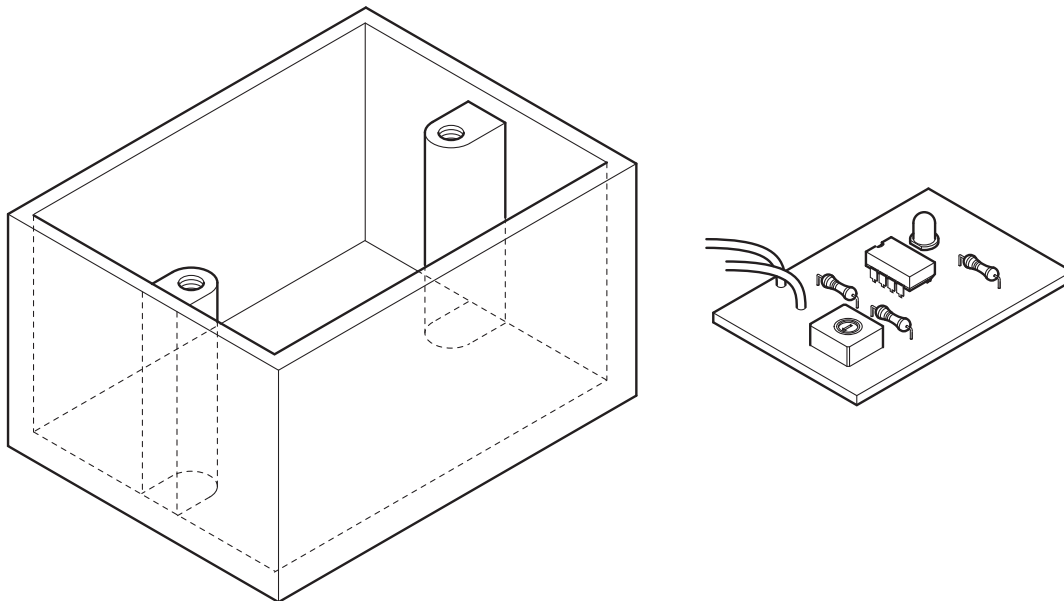


Fig. 17

[3]

[Total: 12]

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