Candidate Name	Centre Number	Candidate Number

OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

General Certificate of Secondary Education

DESIGN AND TECHNOLOGY
(SYSTEMS AND CONTROL TECHNOLOGY)

PAPER 4: ELECTRONICS
HIGHER TIER

1957/4
1953/2
1053/2

Specimen Paper 2003

Additional materials: Formulae Sheet OCR (Tables 2).

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the boxes above.

Answer **all** questions.

Write your answers, in blue or black ink, in the spaces provided on the question paper.

Read each question carefully and make sure you know what you have to do before starting your answer.

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.

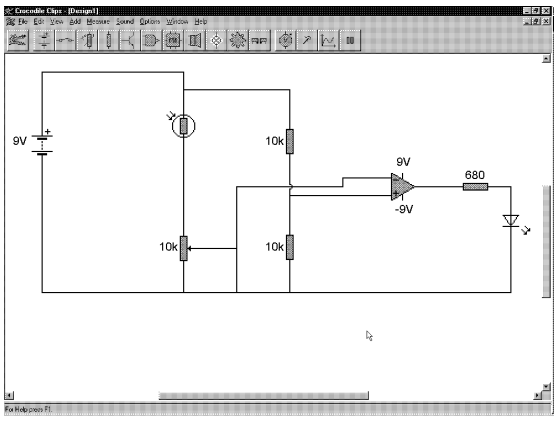
Marks will be awarded for the use of correct conventions.

Dimensions are in millimetres unless stated otherwise.

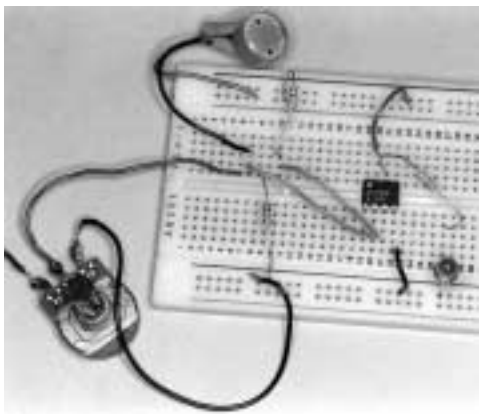
Total marks for this paper is **50**.

Question Number	For Examiner's use only
1	
2	
3	
4	
5	
TOTAL	

1 When designing electronic circuits the correct operation of the circuit has to be tested before manufacture. Fig. 1 shows two ways of testing a circuit.



CAD software



breadboard

Fig. 1

(a) **(i)** State two reasons for using CAD software to test a circuit.

1 _____

_____

2 _____

_____ **[2]**

(ii) Describe two advantages, other than cost, of using a breadboard instead of using CAD software.

1 _____

_____

2 _____

_____ **[2]**

(b) **(i)** PCB design software will often allow information to be saved in a way that is suitable for directly operating a CNC drill or milling machine.
Explain why this method is mainly used for batch production of circuit boards rather than for job (one off) production.

_____

_____

_____ **[2]**

(ii) Chemicals used in the manufacture of PCBs can cause environmental damage if they are not properly disposed of.

State two ways of assessing risk before disposing of the chemicals.

1 _____

2 _____ **[2]**

(c) Fig. 10a shows the design for panel cut-outs to allow sound from a speaker to be heard. The panel is shown in Fig. 2b in a CNC milling machine.

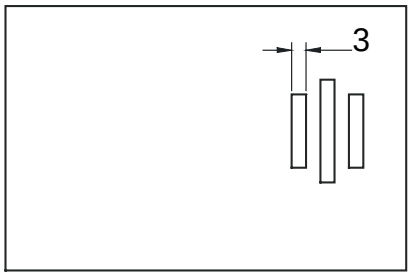


Fig. 2a

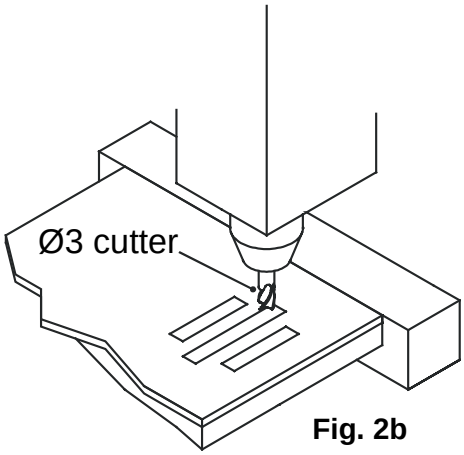


Fig. 2b

(i) The machine will be unable to produce the cutouts as shown.

Use notes or sketches to show how the design of the slots could be altered to allow the machine to produce them.

[1]

(ii) Explain why it is unlikely that a large batch of panels would be produced in this way.

_____

_____ **[1]**

2 **(a)** Fig. 3 shows a multimeter case of the type frequently used in schools.

(i) Describe one feature of the case that could indicate injection moulding as a manufacturing method.

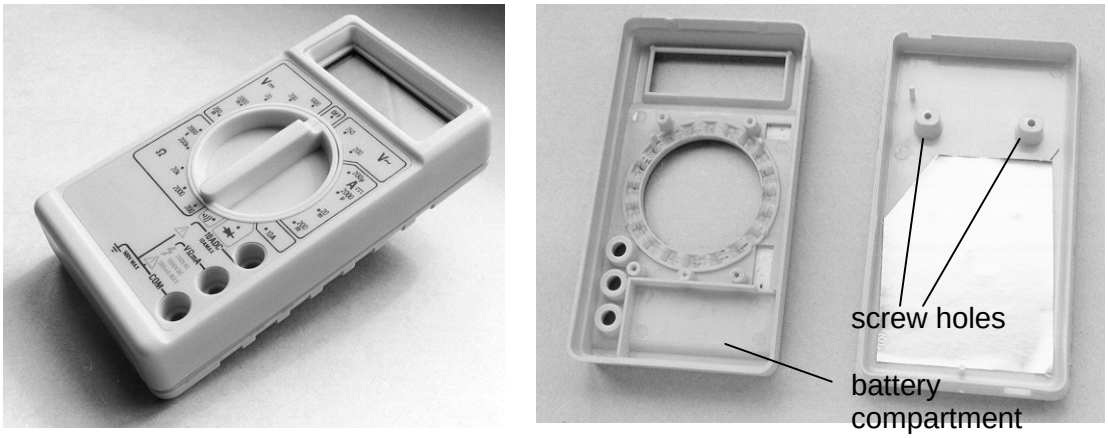


Fig. 3

_____ **[1]**

(ii) State two properties that a suitable material for the multimeter case will need.

1 _____

2 _____ **[2]**

(b) **(i)** Fig. 4 shows clips that hold the display in position. Tests on the material used for the clips show that it can crack after repeated flexing.

Explain why this is unlikely to cause a problem.

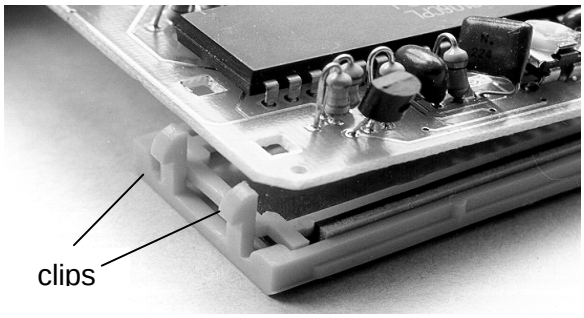


Fig. 4

_____

_____ **[1]**

(b) **(ii)** The display of the multimeter shown in Fig. 5 is a liquid crystal display (LCD).

Explain why an LED display would not be suitable.

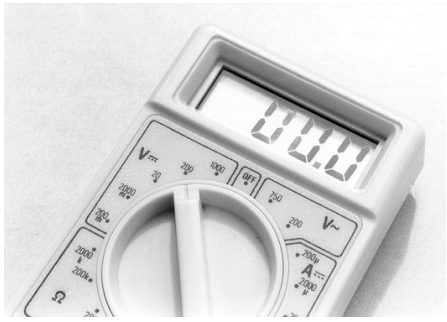


Fig. 5

_____

_____ **[1]**

(iii) The display is housed in a deep recess in the body of the multimeter. Give a possible reason for this.

_____ **[1]**

(c) **(i)** Fig. 6 shows a view of the circuit board. Describe two visible features indicating that the designers have tried to make the unit as compact as possible.

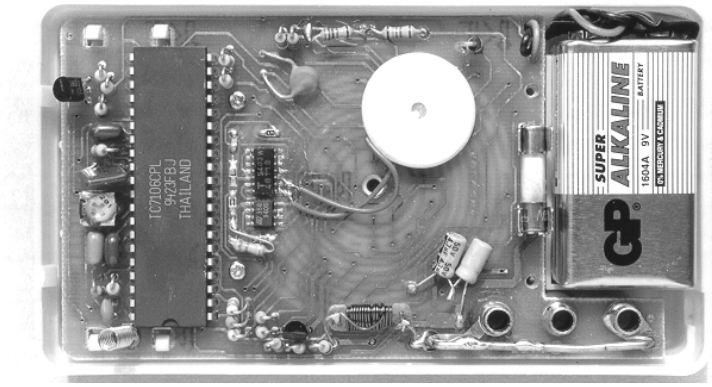


Fig. 6

_____

_____ **[2]**

(ii) Identify two components in the multimeter that required accurate measurements to be taken before the design of the case and circuit board could be finalised.

1 _____

2 _____ **[2]**

3 A manufacturer is designing a security code system for car radios.

The code is entered by pressing a button on the radio until the correct number between 0 and 9 appears on the display. Each digit is then stored as a binary number.

(a) Write the missing numbers in Fig. 7 to show the complete code in both binary and decimal.

Binary number	Decimal number
0100	4
0111	
	9
0011	3

Fig. 7 **[2]**

(b) **(i)** Fig. 8 shows a counter IC set up to test the circuit.

Add to Fig. 8 a **normally closed** switch and pull up resistor to provide a **logic 1** signal when the switch is pressed and a **logic 0** when it is released.

The signal should be connected to the clock input.

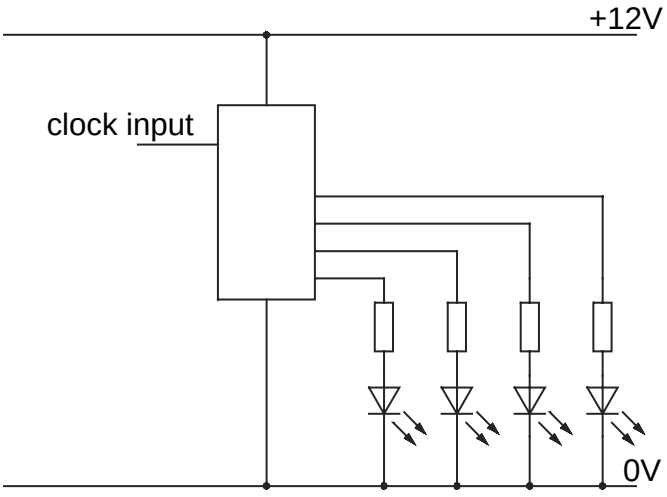


Fig. 8 **[2]**

(ii) Explain the likely reason for the count jumping by two or three each time the switch is pressed.

_____

_____ **[2]**

(iii) Fig. 9 shows two logic gates used to overcome this problem.

Add connections to Fig. 9 to connect all of the unused inputs to logic 0.

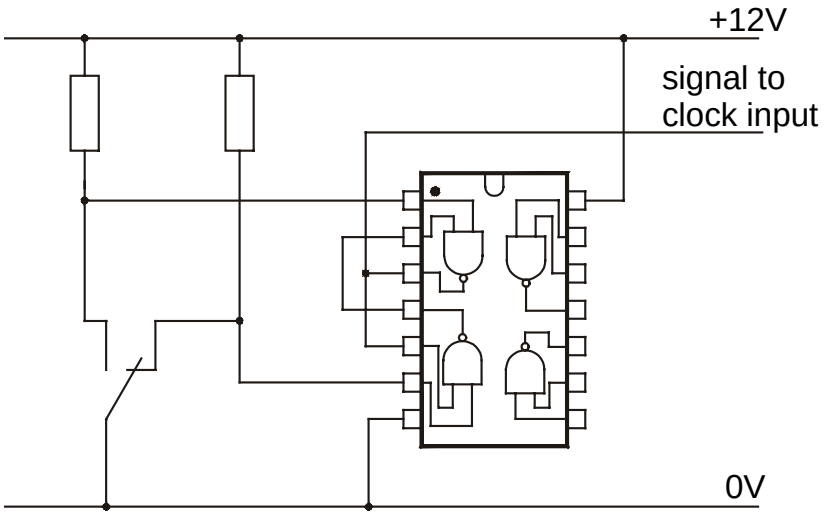


Fig. 9 **[2]**

(c) Using the catalogue information shown in Fig. 10 complete the order code for the logic IC and the most suitable switch.

IC number	Description	Order Code
4000B	Dual 3 input NOR gate	55-0000
4001B	Quad 2 input NOR gate	55-0001
4002B	Dual 4 input NOR gate	55-0002
4011B	Quad 2input NAND gate	55-0011
4012B	Dual 4 input NAND gate	55-0012
4072B	Quad 4 input OR gate	55-0072
4093B	Quad 2input NAND Schmitt	55-0093

Description	Type	Order Code
Miniature rocker switch	SPST	73-0170
Push switch	SPST	74-1382
Tactile switch	SPST	74-1560
Microswitch	SPDT	75-1500
Slide switch	DPDT	76-0100

Fig. 10

IC order code _____

Switch order code _____ **[2]**

4 An automatic washing machine is filled by water entering the drum through a solenoid valve. The solenoid is switched on by a control circuit and switches off when the water reaches a set level. The block diagram in Fig. 11 illustrates the system.

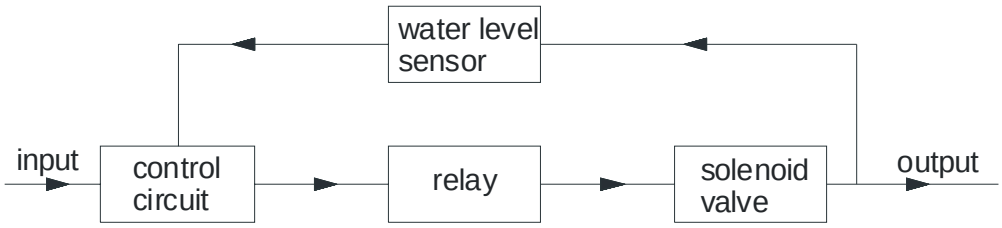


Fig. 11

(a) Describe the part played by the water level sensor within the system.

_____

_____ **[2]**

(b) Output from the control circuit is amplified through a ULN2803 Darlington driver IC. Fig. 12 shows details of the IC, which will power a relay coil.

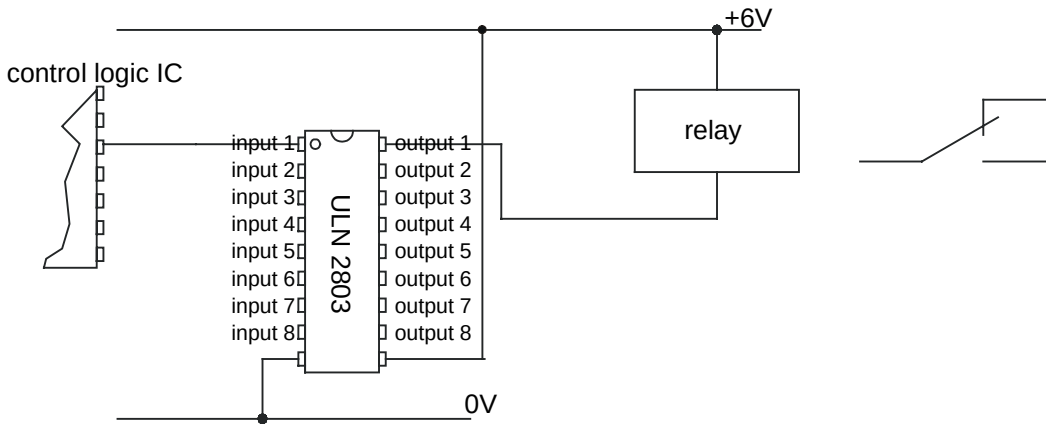


Fig. 12

Describe the purpose of two additional components that would be needed in a circuit using separate transistors.

1 _____

2 _____ **[2]**

(c) The washing machine specification requires a 12V solenoid valve to be used.

Fig. 13 shows technical data for the solenoid.

Technical Specification	
Supply voltage	11.8 - 13.5Vdc
Coil resistance at 25°C	60Ω±10%

Fig. 13

(i) Calculate the maximum current flow that could be expected when testing the finished circuit. The supply has been measured at 12Vdc.

[3]

(ii) The solenoid valve is operated through a relay.

Complete the circuit in Fig. 14 to show how the current flow could be measured when carrying out a test with the solenoid operating.

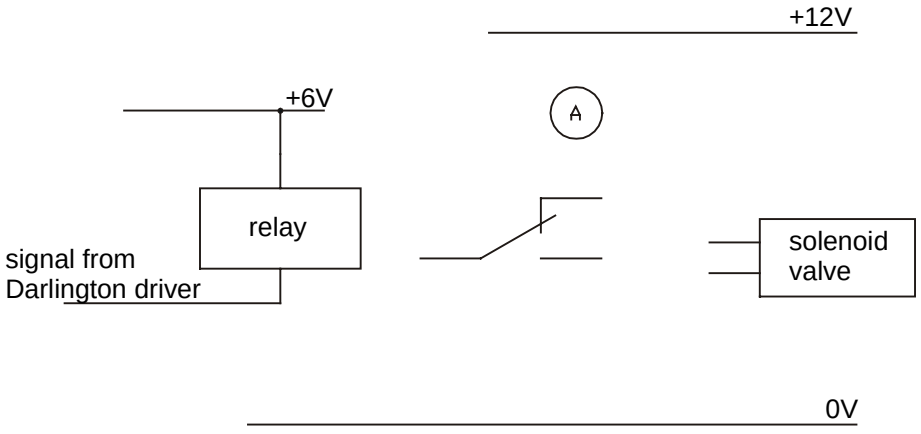


Fig. 14 **[3]**

5 A warning device indicates that a car's headlights have been left on.

Fig. 15 shows the circuit diagram and breadboard layout.

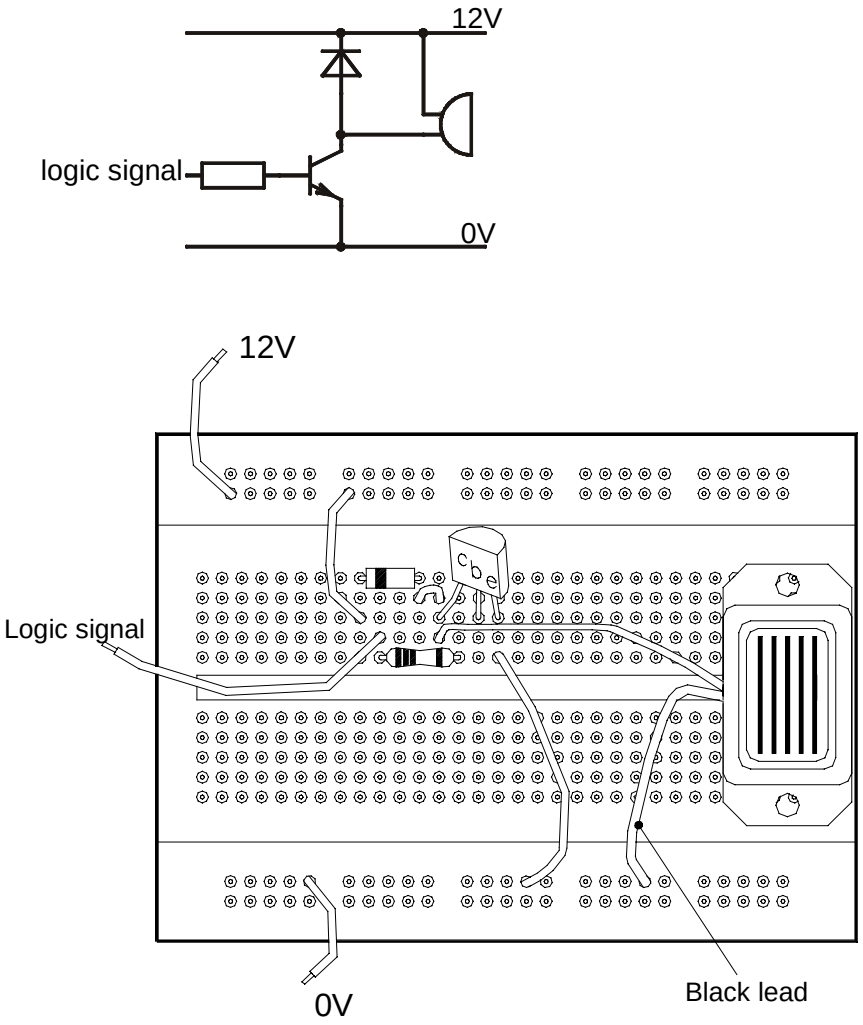


Fig. 15

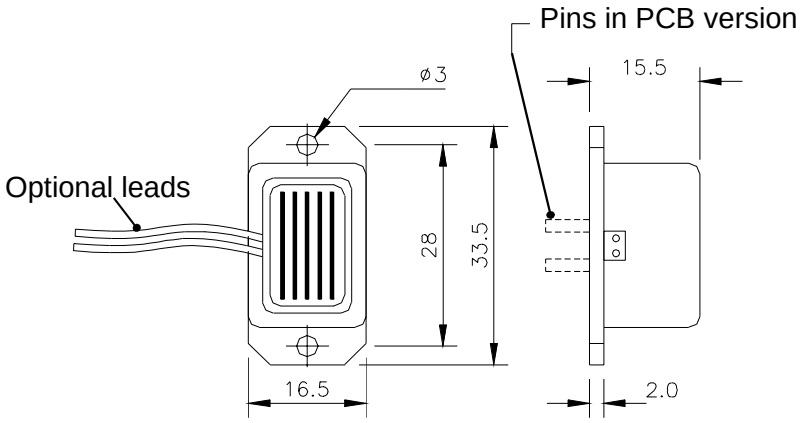
(a) Describe the changes that will be needed to make the circuit work.

_____

_____

_____ **[2]**

(b) Fig. 16 shows details of suitable buzzers from a supplier's catalogue.



	1+	25+	100+
12V buzzer (leads)	£0.58	£0.50	£0.44
12V buzzer (PCB)	£0.65	£0.55	£0.49

Fig. 16

(i) Use sketches to show how the buzzer with leads can be fixed to a circuit board.

The fixing should not be permanent, but it should be secure against vibration.

[2]

(ii) Explain why a manufacturer would probably use the PCB mounted version of the buzzer if a large number of circuits are required, even though it is more expensive.

_____

_____ **[2]**

(c) The device has three inputs to its logic system.

Input **1** Any lights left on give a **logic 1** signal.

Input **2** The engine switched off gives a **logic 0** signal.

Input **3** The driver's door open gives a **logic 0** signal.

Fig. 17 shows the PCB layout for the logic system, which is built from four **NOR** gates.

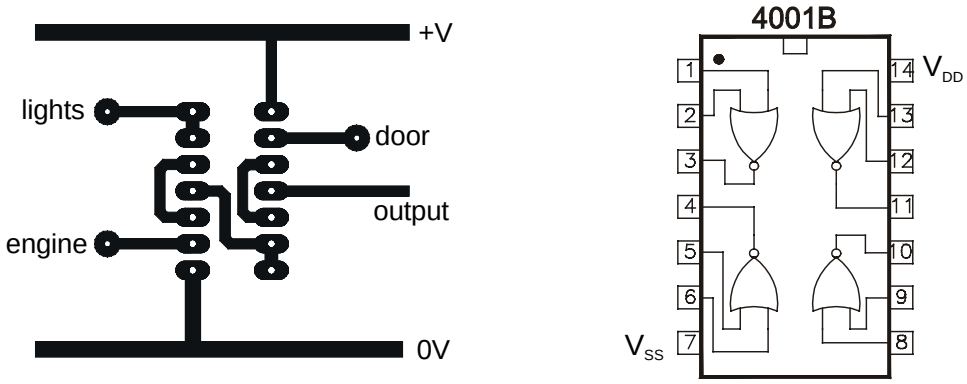


Fig. 17

Complete Fig. 18 to show the circuit diagram of the logic gates.

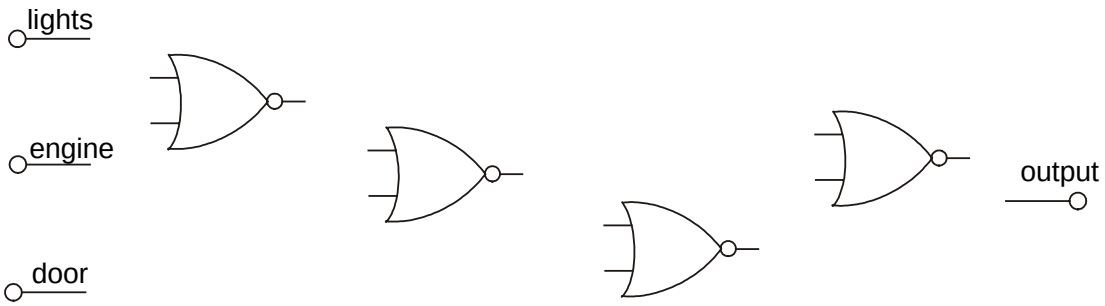


Fig. 18

[4]

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PAPER 4: ELECTRONICS

HIGHER TIER

MARK SCHEME

Specimen Paper 2003

1 **(a)** **(i)** Changes to components can be made quickly, no chance of damaged components, test measurements easily made, Easy to see logic / voltage at each stage. 1 mark for each valid reason. **[2]**

(ii) Size of components can be seen, real response may be different to simulated circuit, tests can be made in correct situation, e.g. light / dark, no need for expensive equipment / software. 1 mark for each valid reason. **[2]**

(b) **(i)** Time taken to set machine up, expense of CNC machines, time taken to allow for different hole sizes, 1 mark each for reason related to time / expense. **[2]**

(ii) Manufacturers data sheet, COSHH datasheet. 1 mark for each. **[2]**

(c) **(i)** Notes or sketches to show the slots with round ends to match shape of cutter. **[1]**

(ii) Machining time would be to long, more likely to be injection moulded, high cost of machine. **[1]**

[Total: 10]

2 **(a)** **(i)** Evidence of draft or taper angle, material used, internal webs, fillets / radius on corners, marks left by ejector pins etc. **[1]**

(ii) Material must be an electrical insulator, able to withstand likely working temperatures, slightly flexible, not brittle, available in different colours, thermoplastic, suitable for injection moulding, 1 mark each for valid property. **[2]**

(b) **(i)** It is likely that the display will remain in place during working life of meter, it will only need to be flexed a small number of times **[1]**

(ii) High current draw of LED display, frequent battery replacement needed. **[1]**

(iii) To avoid reflections obscuring the display, to provide some protection from scratching / damage. **[1]**

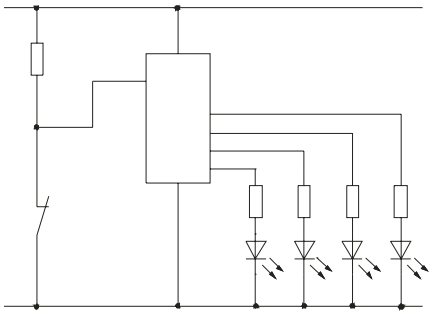
(c) **(i)** Use of resistors in vertical position, PCB fits right up to edge of case, surface mount components, PCB cut to follow shape of battery, no IC holders used. 1 mark each. **[2]**

(ii) Battery, fuse (length), diameter of lead connectors, display dimensions, main IC. 1 mark for each component. **[2]**

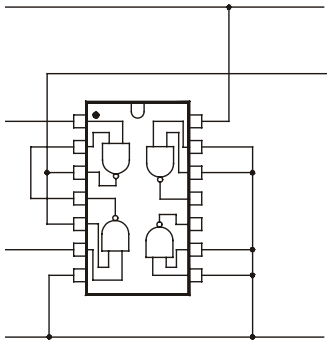
[Total: 10]

3 **(a)** 0111 = 7, 1001 = 9, 1 mark for each correct. **[2]**

(b) **(i)** 1 mark for resistor, 1 mark for PTB switch **[2]**



(ii) Contact bounce or an understanding of contact bounce 1 marks;
causes unwanted pulses to go to counter 1 mark. **[2]**



(iii) 1 mark for each pair of inputs correctly tied to 0V. **[2]**

(c) Order code for IC **55-0011**, 1 mark
order code for switch **75-1500**, 1 mark **[2]**

[Total: 10]

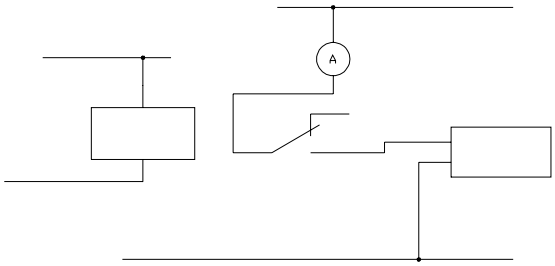
4 **(a)** Provides feedback, 1 mark.

Causes the input to be altered as a result of changing output, 1 mark. **[2]**

(b) Base resistor to protect the base of transistor, 1 mark.
Diode to protect transistors from reverse emf, 1 mark. **[2]**

(c) **(i)** Resistance range = R54 - R66, 1 mark
Using lowest resistance maximum current = 12 / 54, 1 mark
= 0.222A or 222mA, 1 mark **[3]**

(ii)



Ammeter connected in series, 1 mark.
Relay connections correct, 1 mark.
Solenoid to 0V, 1 mark. **[3]**

[Total: 10]

5 **(a)** Base resistor to be connected, 1 mark.

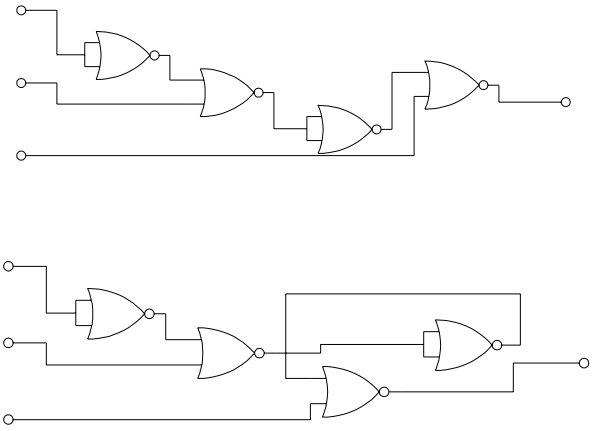
Buzzer to be connected between collector and positive rail, 1 mark. **[2]**

(b) **(i)** Screw and nut using spring washer or stiff nut to secure against vibration.
1 mark for securing to board.
1 mark for security against vibration.
Double sided pads 1 mark only. Buzzer body must be fixed to board. **[2]**

(ii) Ease of assembly, no danger of broken leads, no extra drilling needed, less parts used, machine assembly, any two relevant points, 1 mark each. **[2]**

5 **(c)** 1 mark for each gate correctly connected.

Both inputs and output must be correct for mark.



[4]

[Total: 10]

Total mark 50

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