OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

General Certificate of Secondary Education

A514/01

Design and Technology
Electronics and Control Systems: Electronics

Unit A514: Technical aspects of designing and making

Specimen Paper

Time: 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name 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 you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do not write in the bar codes.
- Do not write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- Your Quality of Written Communication is assessed in questions marked with an asterisk (*).
- The total number of marks for this paper is 60.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

Section A

Answer **all** questions.

1 A student is designing a PIC based device to monitor temperature in a greenhouse. A diagram of the system is shown in Fig. 1.

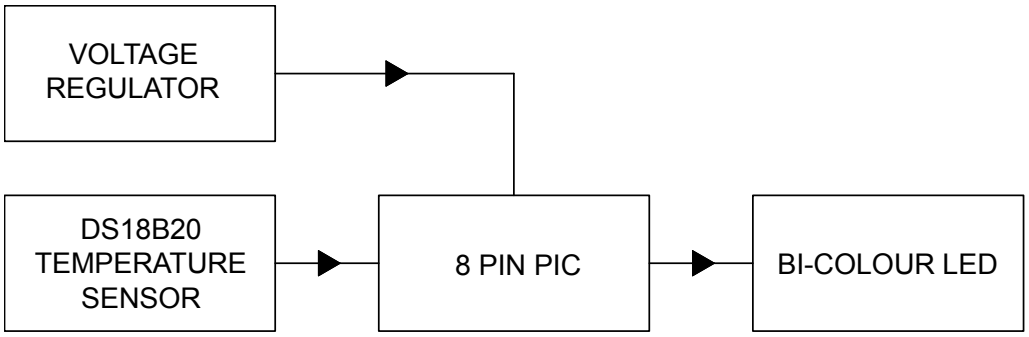


Fig. 1

(a) (i) One of the input boxes in Fig. 1 is a voltage regulator. State the purpose of a voltage regulator in a PIC circuit.

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

(ii) Fig. 2 shows part of the voltage regulator circuit. Add the following connections to Fig. 2.

- Battery positive to 7805 input
- 7805 output to PIC pin 1
- PIC pin 8 to 0V

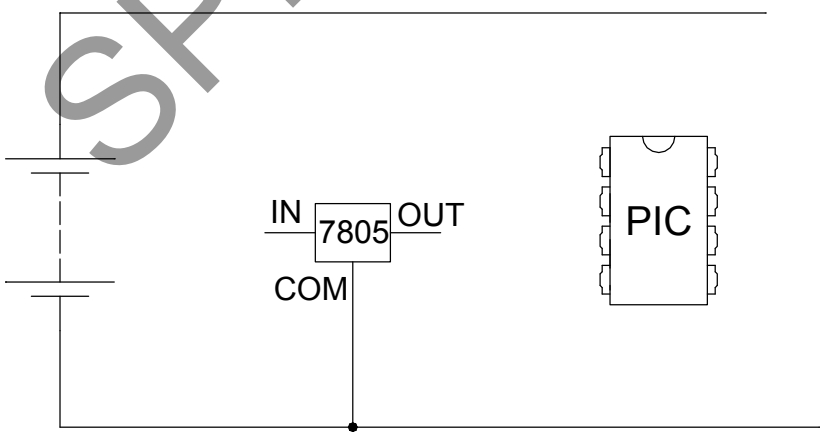


Fig. 2

[3]

(b) The temperature sensor is a DS18B20 as shown in Fig. 3. This device sends temperature to the PIC in °C. Stranded wire has to be attached to each of the sensor pins.

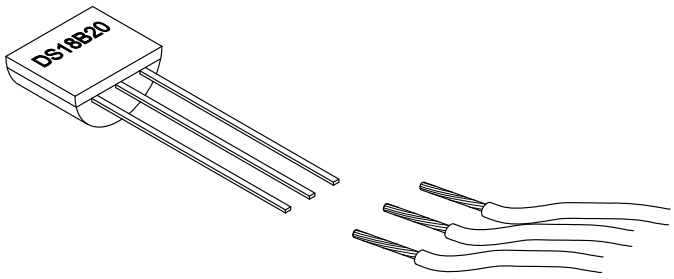


Fig. 3

(i) Describe **two** stages in soldering one of the wires to one leg of the sensor.

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

2 . ..... **[1]**

(ii) Give **one** method of insulating the three legs of the sensor when all wires have been attached.

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

(c) A bi-colour LED will be used to indicate when temperatures are too high or too low in the greenhouse. The program flowchart includes the decision boxes shown in Fig. 4.

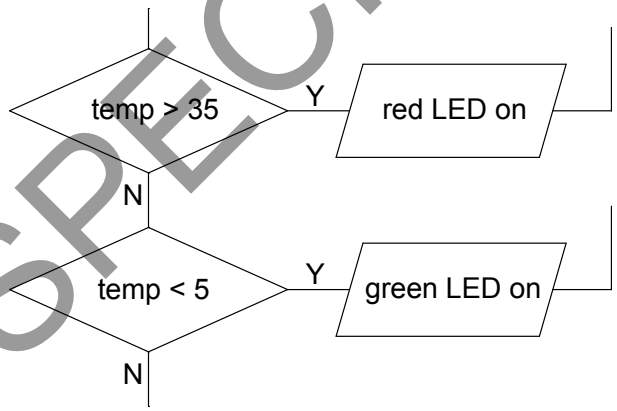
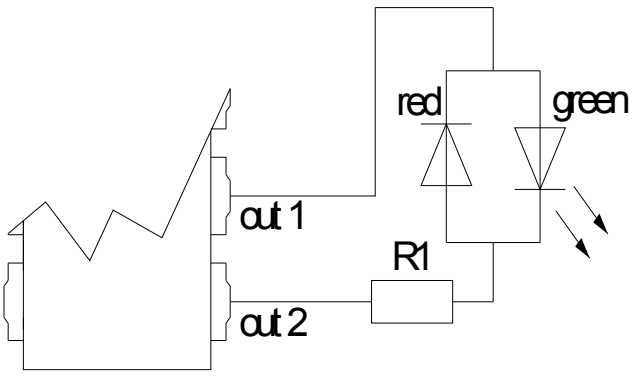


Fig. 4

State the temperature range when neither LED is on.

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

(d) (i) Fig. 5 shows the circuit arrangement for the bi-directional LED. Complete the truth table to show which LED will be switched on for all possible combinations of output 1 and output 2.



out 1	out 2	red LED	green LED
0	0	off	off
0	1		
1	0		
1	1		

Fig. 5

[1]

(ii) Resistor R1 has to be a suitable value to restrict the current in the LED to 15mA. The supply voltage for the PIC chip is +5V. The voltage drop on the LED is 1.7V. Calculate the value of R1. Use the formula V = I x R

.....

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

[Total: 12]

2 Many electronic products use a small mains adaptor as shown in Fig. 6.

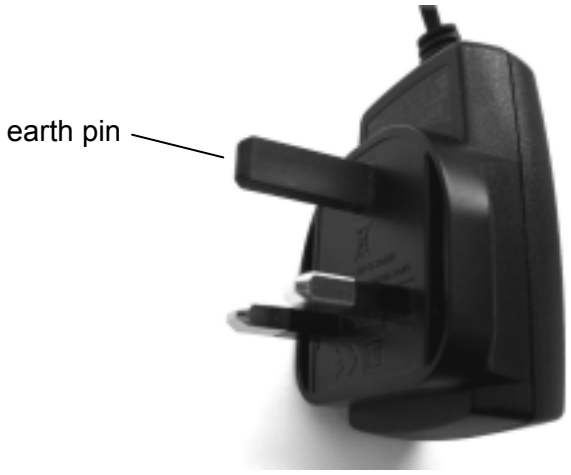


Fig. 6

(a) Discuss why the mains adaptor shown in Fig. 6 has been designed using moulded construction and the pins have been designed in the pattern shown in Fig. 6.

.....

.....

.....

.....

..... **[4]**

(b) Fig. 7 shows the output of a mains adaptor being tested with a multimeter.

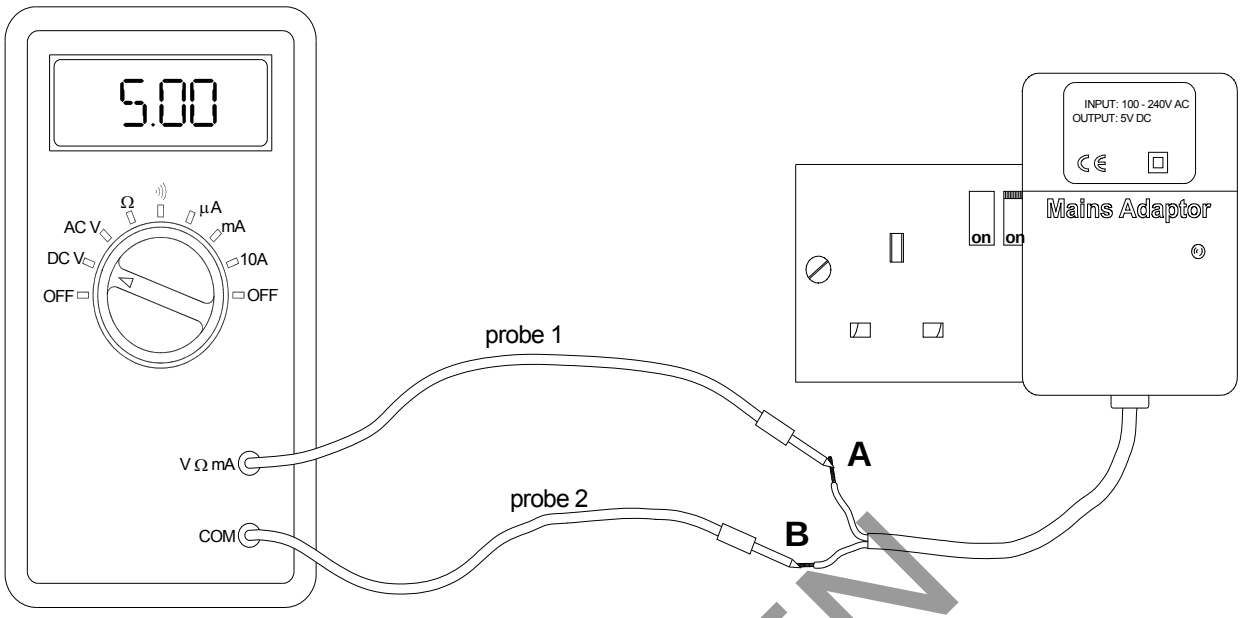


Fig. 7

(i) Label the positive lead from the mains adaptor. **[1]**

(ii) Give the multimeter reading that could be expected if:

probe 1 was connected to **B** and probe 2 was connected to **A**.

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

(c) Circuits powered by a mains adaptor or a battery will often use a component at the input to prevent damage if the power leads are reversed. Fig. 8 shows a view of the component next to the start of a circuit diagram.

Add the correct symbol for the component to the circuit diagram.

pictorial view of component

Fig. 8

[2]

(d) Power to a logic circuit has to be smooth with no ripples.

In Fig. 9 an oscilloscope screen shows the output of a mains adaptor.

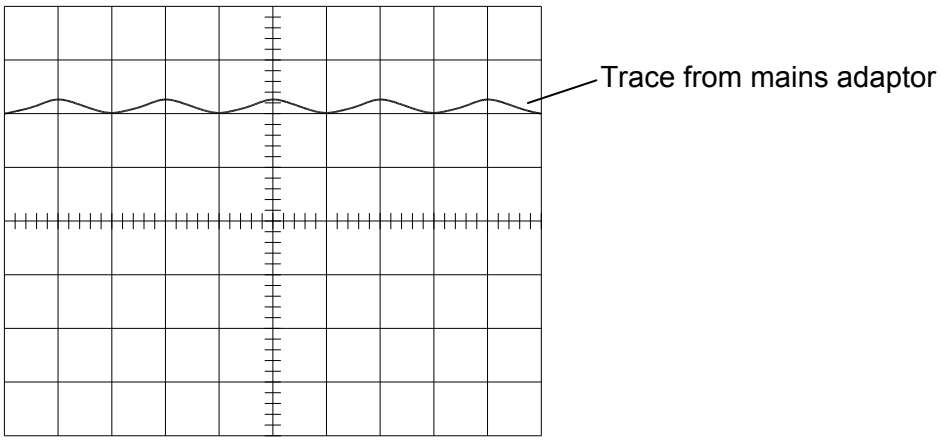


Fig. 9

(i) Give the name and suitable value of a component that can smooth the ripples on the output.

Name of component ..... **[1]**

Suitable value ..... **[1]**

(ii) Explain how the smoothing action is achieved.

.....

.....

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

[Total: 12]

3 **(a)** Fig. 10 shows a circuit diagram and a correctly constructed breadboard layout for an astable circuit.

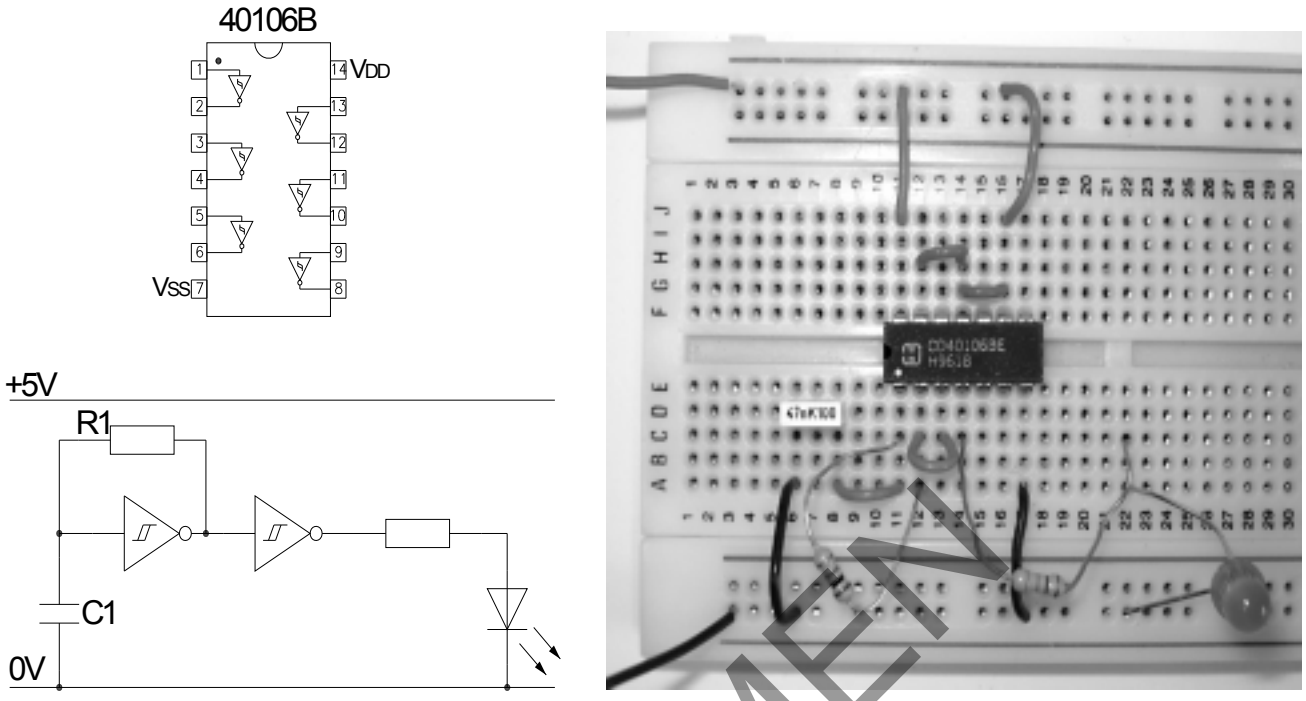


Fig. 10

(i) When tested the LED appears to be permanently on.

State the most likely reason for this.

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

(ii) Give the name of the logic gate used.

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

(iii) State how the circuit could be altered to improve the chance of seeing if it is working correctly. No test instruments are available.

.....

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

(b) Fig. 11 shows part of a PCB layout for the circuit.

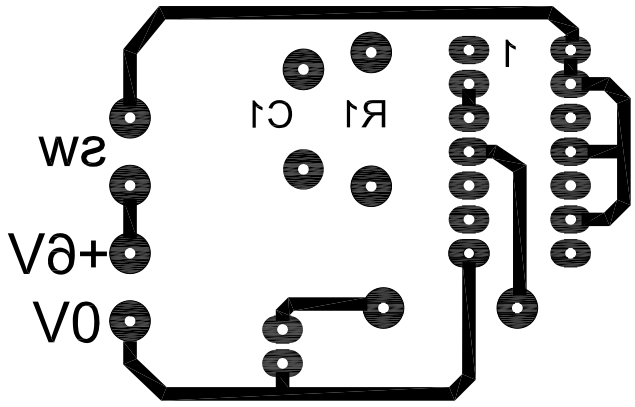


Fig. 11

On the PCB layout add the tracks to R1 and C1. **[2]**

(c) Accurate construction techniques are needed if the circuit is to operate correctly.

(i) Fig. 12 shows a soldered joint that has bridged across two pads. Describe **one** method of removing the excess solder.

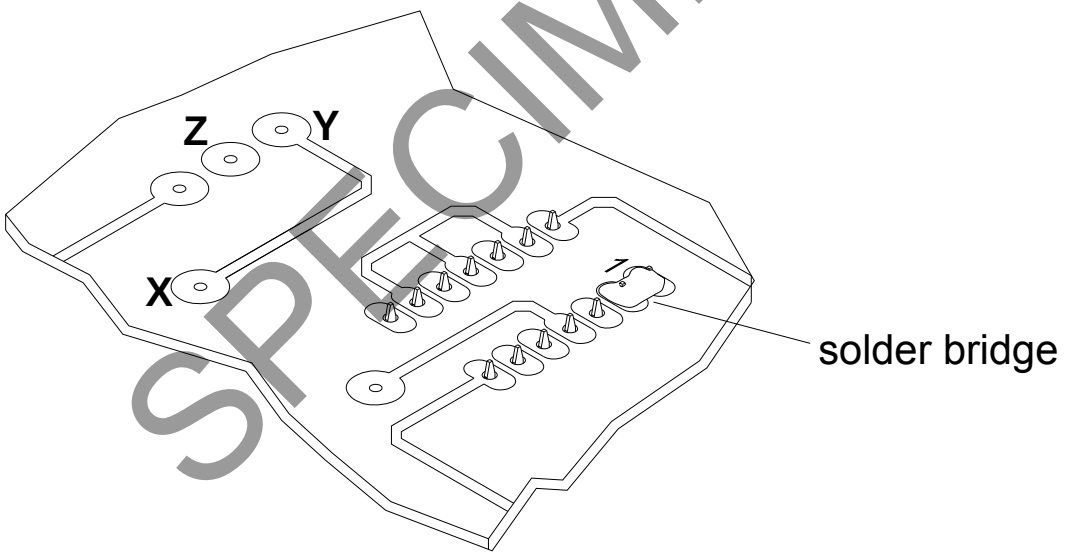


Fig.12

.....

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

(ii) A track between points X and Y can be seen in Fig. 12 The track is incorrectly positioned and the correct connection should be between X and Z. Give **two** stages in correcting the fault.

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

2. . ..... **[1]**

(iii) Printable circuit technology could be used to produce the circuit shown in Fig. 12. Describe **two** benefits of printable circuit technology.

1 .....

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

2 .....

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

[Total: 12]

Section B

Answer all questions

4 A supermarket requires a display to show the ticket number for the next customer at a fresh food counter. The display will be operated by any one of four push switches spaced along the counter. Fig. 14 shows the proposed layout of the system.

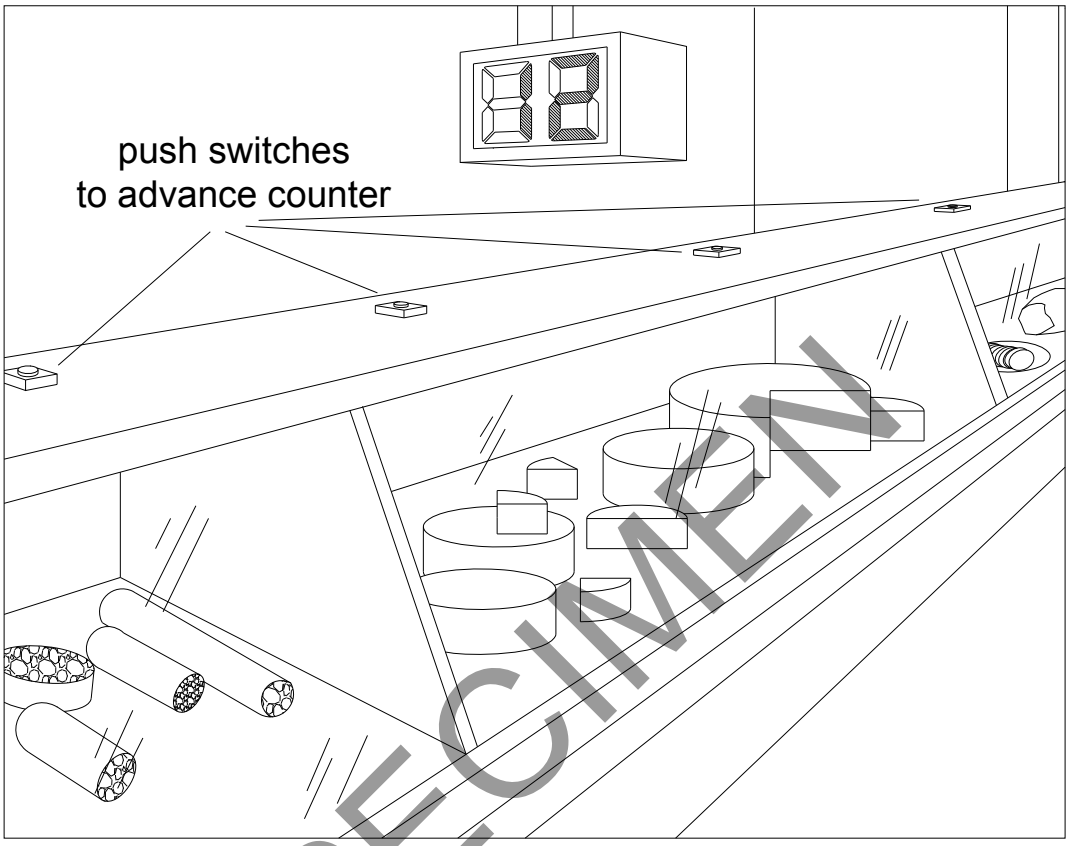


Fig. 14

(a) Before the design can go ahead a specification has to be completed.

(i) Give **one** specification point based on the **function** of the system.

.....

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

(ii) Give **one** ergonomic specification point.

.....

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

(b) The four push switches will be input to a logic circuit that will allow any one of the four to advance the count on the display. Complete Fig. 15 using notes and sketches to show a suitable logic system.

.....

.....

.....

Fig. 15

[3]

(c) The counter requires a clean digital signal from the switches.

Use notes and sketches to explain how the clean digital signal can be produced.

.....

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[3]

(d) Fig. 16 shows a pinout diagram of a 4026B decoded decimal counter IC.

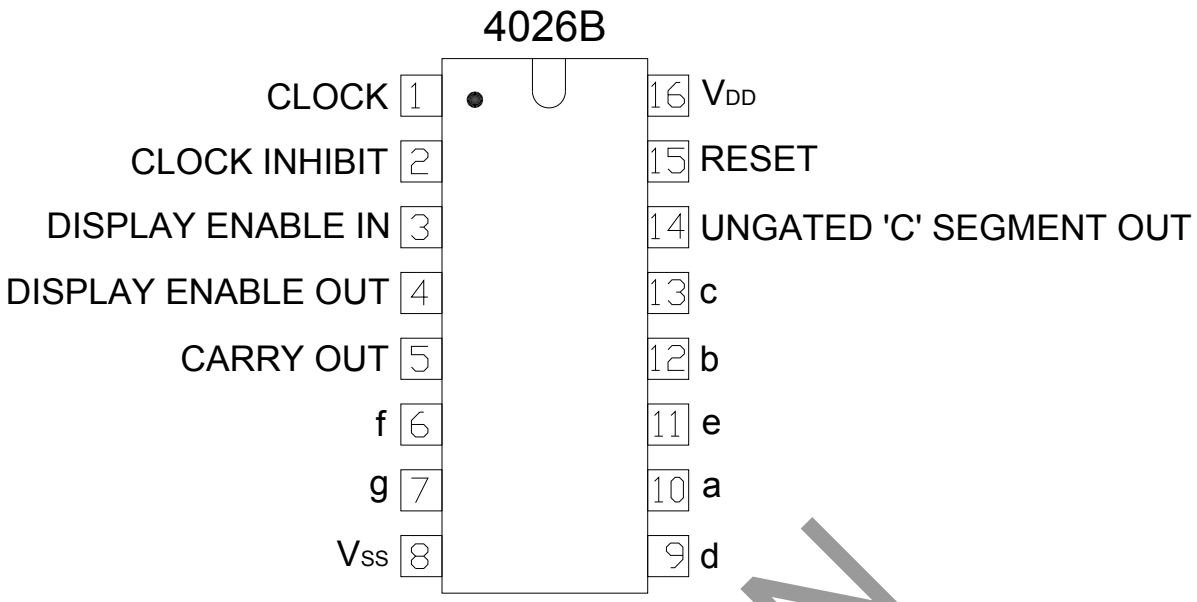

Fig. 16

(i) State the use of the CARRY OUT pin.

.....

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

(ii) Give **one** additional function that can be provided by the 4026B.

.....

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

(e) At the prototype PCB stage quality control has to be considered.

Describe how the circuit designer can make quality control and testing of a circuit board more efficient.

.....

.....

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

[Total: 12]

5 The component parts of a small amplifier are shown in Fig. 17

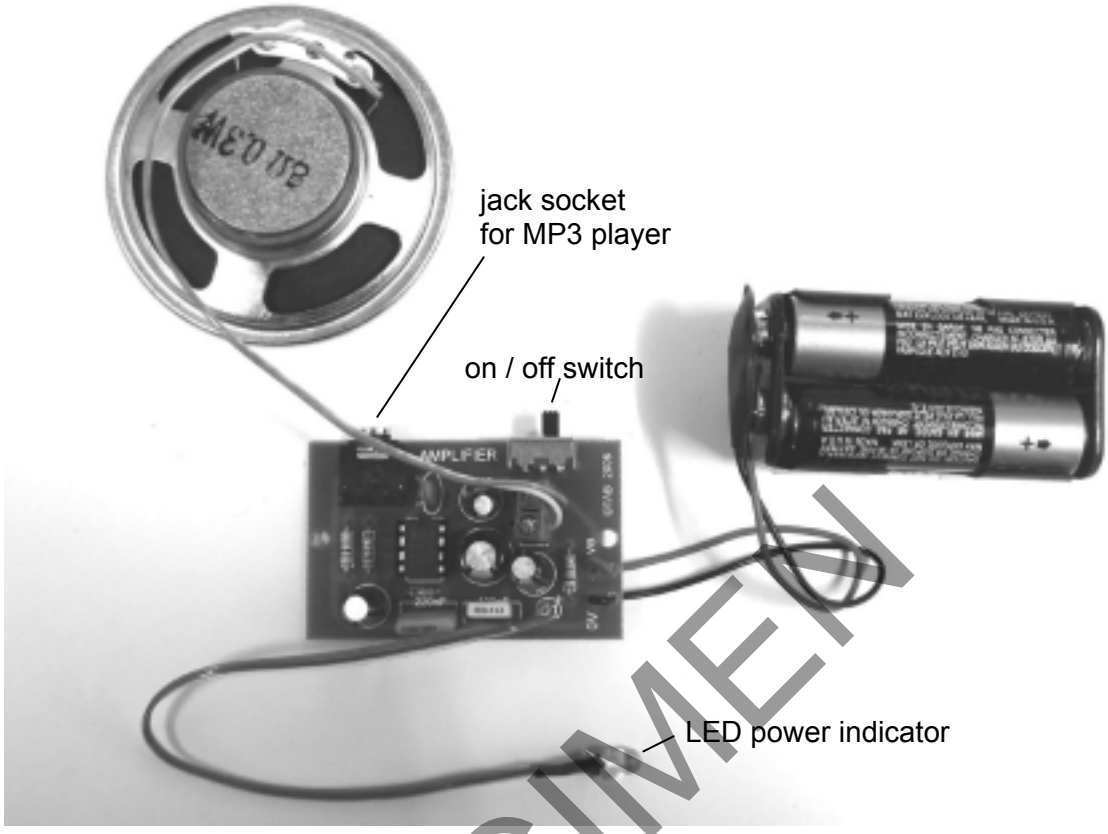

Fig. 17

These components will be packaged as a product within an injection moulded plastic casing.

(a) The casing is to be made in two parts; a base, which the circuit will be attached to and the top which houses all of the component parts.

Use notes and sketches to show how the two parts of the casing could be made to fit together accurately and securely.

.....

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

(b) The PCB needs fixing to the base using a method that will provide height adjustment.

Use notes and sketches to show how this can be done.

.....

..... .

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

(c) Use notes and sketches to show how a 3mm jack plug socket would be fitted to the casing.

..... .

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

(d)* Discuss why the amplifier manufacturer has chosen to produce the casing using the injection moulding process.

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..... **[5]**

.....

[Total: 12]

Paper Total [60]

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

General Certificate of Secondary Education

DESIGN AND TECHNOLOGY A514/01

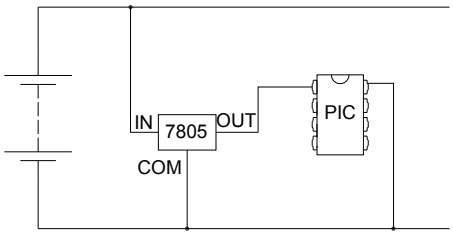
Electronics and Control Systems: Electronics

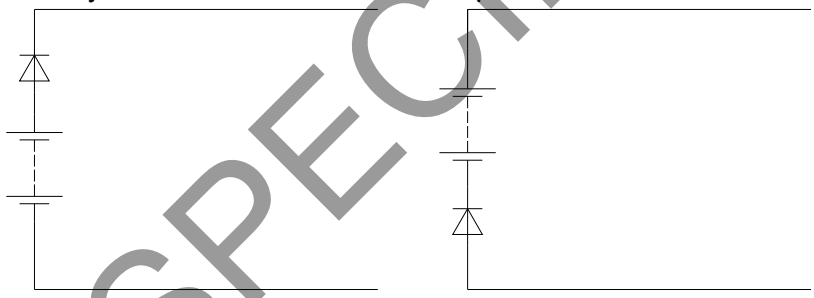
Unit A514: Technical aspects of designing and making

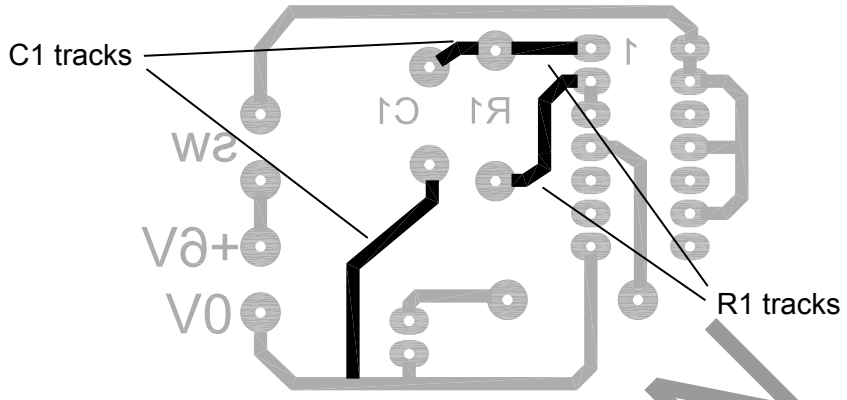
Specimen Mark Scheme

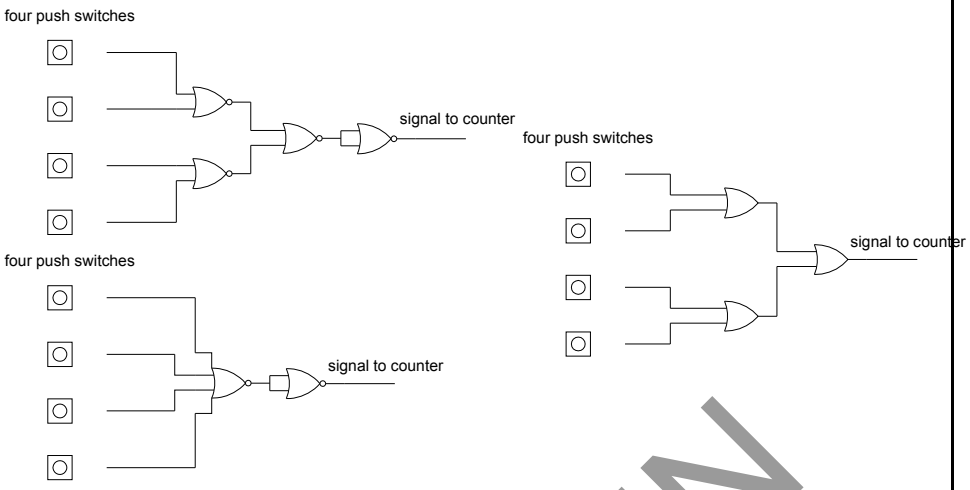
The maximum mark for this paper is **60**.

This document consists of **7** printed pages.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Max Mark</th></tr>
<tr><td>1(a)(i)</td><td>Voltage regulator is to supply a set level of voltage from a range of input voltage values, e.g. 7805 gives 5V from an input ranging from 6 – 35V, allow mark for understanding shown.</td><td>[1]</td></tr>
<tr><td>(ii)</td><td>Positive connection 1 mark, 7805 output to PIC pin 1 1 mark, PIC pin 8 to 0V mark.
 
</td><td>[3]</td></tr>
<tr><td>(b)(i)</td><td>Soldering stages could include:
• tinning the soldering iron;
• tinning component legs / wires;
• twisting wire around leg;
• heating joint;
• feeding solder into joint;
2 x 1 marks; stages need not be in correct order.</td><td>[2]</td></tr>
<tr><td>(ii)</td><td>Heat shrink sleeving, allow insulating tape or plastic tape. 1 mark.</td><td>[1]</td></tr>
<tr><td>(c)</td><td>Temperature range is 5 – 36. 1 mark for each correct value.</td><td>[2]</td></tr>
<tr><td>(d) (i)</td><td>0 1 red LED on, 1 0 green LED on. Both correct 1 mark.
<table>
<tr><th>out 1</th><th>out 2</th><th>red LED</th><th>green LED</th></tr>
<tr><td>0</td><td>0</td><td>off</td><td>off</td></tr>
<tr><td>0</td><td>1</td><td>on</td><td>off</td></tr>
<tr><td>1</td><td>0</td><td>off</td><td>on</td></tr>
<tr><td>1</td><td>1</td><td>off</td><td>off</td></tr>
</table></td><td>[1]</td></tr>
<tr><td>(ii)</td><td>Use of voltage drop 1 mark, correct application of formula to obtain answer 1 mark.
5 – 1.7 = 3.3 R = V / I = $\frac{3.3}{0.015}$ = 220R</td><td>[2]</td></tr>
<tr><td></td><td>Total</td><td>[12]</td></tr>
</table>

Question Number	Answer	Max Mark
2(a)	Candidate analyses the product to establish the main issues in designing the plug A low level response with limited understanding of the issues [0-2 marks] One or two of the issues are identified and developed to justify the design [3-4 marks] All key issues are identified and developed and the design of the plug is justified [5 marks] Key issues may include: that casing is double insulated and does not need an earth connection. The adaptor is sealed to prevent any user access for safety, allow reference to safety. Discussion could include, will only fit one way in socket, earth pin is connected before live and neutral, live and neutral are insulated to protect from a child's finger being inserted behind a plug.	**[4]**
(b)(i)	Label should clearly indicate lead from VΩMa to point A.	**[1]**
(ii)	Reading will be **-5.0**. Allow mark if negative reading is referred to.	**[1]**
(c)	Diode symbol correct 1 mark, correct position 1 mark. 	**[2]**
(d)(i)	Electrolytic capacitor, 1 mark, suitable value 1000µF, allow value from 470µF to 2000µF.	**[2]**
(ii)	Explanation should refer to capacitor charging on positive part of wave form (rising voltage) and discharging as voltage drops, 1 mark for capacitor charging and discharging, 1 mark for effect on voltage level.	**[2]**
	Total	**[12]**
3(a)(i)	LED appears permanently on because it is flashing too fast to see. Allow mark for understanding shown.	**[1]**
(ii)	Schmitt NOT gate or Schmitt inverter. I mark for type of gate 1 mark for reference to Schmitt action.	**[2]**

Question Number	Answer	Max Mark
(iii)	Increase value of C1 1 mark, increase value of R1 1 mark. Allow mark for putting clock signal through a divider circuit.	**[1]**
(b)	C1 tracks both correct 1 mark; R1 tracks both correct 1 mark.  	**[2]**
(c)(i)	Excess solder can be removed by: • Wiping across with a soldering iron; • Using a de-soldering tool; Braided wire to soak up the solder. 1 mark for reheating the joint, 1 mark for method of removal.	**[2]**
(ii)	Track must be cut near to Y 1 mark Extra wire or foil track are used to make the connection from X to Z, 1 mark.	**[2]**
(iii)	Benefits could include, used of flexible substrate / insulator, reduction in copper use, printing onto different materials, 2 x 1 marks for suitable benefits.	**[2]**
4(a)(i)	Specification point must refer to an analysis of the function, e.g. maximum count; number of push switches; type of display; power source. 1 mark for suitable point.	**[1]**
(ii)	Ergonomic point must refer to switch size / position; display size; readability of characters, 1 mark.	**[1]**

Question Number	Answer	Max Mark
(b)	Logic system must allow any one of the four switches to provide input, OR gate, NOR gate or NAND gate combinations could be used, multi input NOR gate.  1 mark for suitable gate chosen, 1 mark for suitable number and arrangement of gates, 1 mark for working solution.	**[3]**
(c)	Suitable debouncing circuit should be used, RS latch, Schmitt trigger, Monostable would be suitable circuits. 1 mark for suitable method, 1 mark for circuit diagram or clear explanation of how it cleans signal, 1 mark for working solution.	**[3]**
(d)(i)	CARRY OUT pin sends a clocking signal to further ICs in a chain of counters. It gives one pulse for every ten input clock pulses. Allow mark for understanding.	**[1]**
(ii)	Clock signal can be filtered out using clock inhibit; display can be prevented using display enable pin; counter can be reset. 1 mark for suitable use.	**[1]**
(e)	Visible display of output stages to confirm it is working; test points built into PCB; screen layer with component positions, and values; 1 mark for each improvement to efficiency mentioned, 2 x 1.	**[2]**
	Total	**[12]**
5(a)	Clear notes / sketches to show method of fitting parts, 1 mark. Indication of securing e.g. rivets, screws etc. 1 mark. Method allows accurate alignment of parts, 1 mark. Analysis of method, would work if used, 1 mark.	**[4]**
(b)	Method used allows PCB to be fixed securely to the base, 1 mark. functional method of height adjustment, 1 mark.	**[2]**

Question Number	Answer	Max Mark
(c)	Clear notes/sketches to show socket in place retained by locking nut, washer, leads soldered to end of socket	**[2]**
(d)*	Level 1 (0-2 marks) Discussion shows limited understanding of the injection moulding process and the issues involved when manufacturing electronic products. There will be little or no use of specialist terms. Answers may be ambiguous or disorganised. Errors of grammar, punctuation and spelling may be intrusive. Level 2 (3-4 marks) Discussion shows some understanding of the injection moulding process some analysis of the issues involved when manufacturing electronic products. Basic conclusions may be drawn. There will be some use of specialist terms, although these may not always be used appropriately. The information will be presented for the most part in a structured format. There may be occasional errors in spelling, grammar and punctuation Level 3 (5 marks) Discussion shows detailed understanding of the injection moulding process and analyses most of the issues involved when manufacturing electronic products. Appropriate conclusions are drawn. Specialist terms will be used appropriately and correctly. The information will be presented in a structured format. The candidate can demonstrate the accurate use of spelling, punctuation and grammar. Discussion may include the following issues: • Speed of process/output • Level of waste • Intricacy or otherwise of process • Volume of production – benefits and drawbacks • Initial set up inc. machinery, retraining, reorganisation • Detail issues	**[5]**
	Total	**[12]**
	Paper Total	**[40]**

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)	4			**4**
1(b)	3			**3**
1(c)	2			**2**
1(d)	3			**3**
2(a)	0		4	**4**
2(b)	2			**2**
2(c)	2			**2**
2(d)	4			**4**
3(a)	4			**4**
3(b)	2			**2**
3(c)	6			**6**
4(a)	2			**2**
4(b)	3			**3**
4(c)	3			**3**
4(d)	2			**2**
4(e)	2			**2**
5(a)	3			**2**
5(b)	2			**2**
5(c)	2			**4**
5(d)*			5	**2**
Totals	**51**	**0**	**9**	**60**