Candidate 1 evidence

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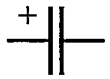
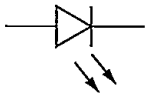
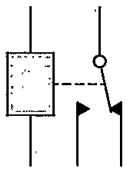
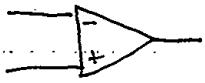
Total marks — 60

Attempt ALL questions

1. (a) The table gives information about some circuit components.
Some of the boxes have been left blank.
Complete the table for the missing entries. 3

Name	*Symbol*	*Function*
electrolytic capacitor		stores charge
LED		emits light
relay		Switches to a high-power circuit
741 operational amplifier (op-amp)		comparator

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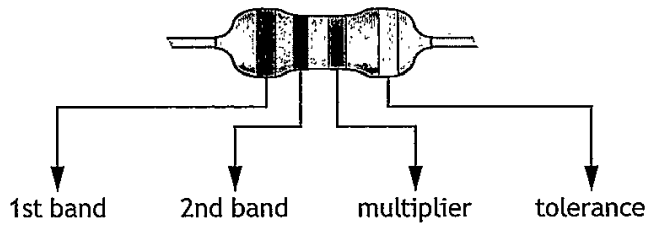
1. **(continued)**

(b) The following diagram shows the colour coding for a resistor.



A student is comparing two resistors R_1 and R_2. The colour code for each resistor is given in the table below.

Resistor	*1st band*	*2nd band*	*Multiplier*	*Tolerance*
R_1	brown	red	orange	silver
R_2	brown	red	orange	brown

Using information from the data sheet:

(i) determine the resistance of resistor R_1; 1

12 KΩ

(ii) state the percentage tolerance value of resistor R_2; 1

± 1%

(iii) determine the colour codes for a resistor of value 6K8 ± 5%. 2

1st band	*2nd band*	*Multiplier*	*Tolerance*
Blue	Grey	Red	gold

[Turn over]

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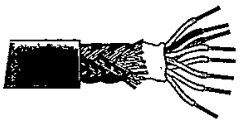
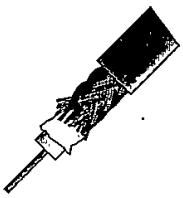
2. Complete the table by stating a typical use for each cable type shown. 2

	Cable type	*Typical use*
	multi-strand	Wire in TVs
	coaxial	Audio cable

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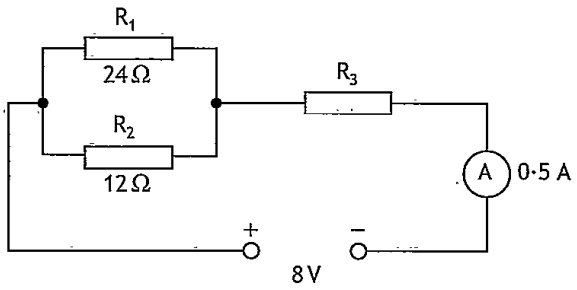
3. A student sets up the circuit shown.



(a) Calculate the total resistance of the circuit. 3

Space for working and answer

$R = \frac{V}{I}$ $R = \frac{8}{0.5}$

$R = 16\,\Omega$

(b) Calculate the effective resistance of R_1 and R_2 in parallel. 3

Space for working and answer

$\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2}$ $\frac{1}{Rt} = \frac{1}{24} + \frac{1}{12}$

$\frac{1}{Rt} = \frac{3}{24}$ $Rt = 8\,\Omega$

(c) Determine the resistance of resistor R_3. 1

Space for working and answer

$Rt = R1 + R2$ $16 = 8 + R3$

$R3 = 8\,\Omega$

MARKS | DO NOT WRITE IN THIS MARGIN

3. **(continued)**

(d) Determine the voltage across R_3. 1

Space for working and answer

$V = IR$ $V = 0.5 \times 8$

$V = 4_V$

(e) Calculate the power dissipated in resistor R_3. 3

Space for working and answer

$P = I^2R$ $P = 0.5^2 \times 8$

$P = 2W$

[Turn over

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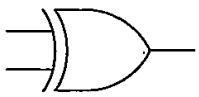
4. Logic gates are widely used in electronic circuits.

(a) Complete the truth table for an OR gate. 1

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

(An additional truth table, if required, can be found on *page 24*.)

(b) Name the logic gate shown below: 1



Exclusive OR gate (XOR/EOR)

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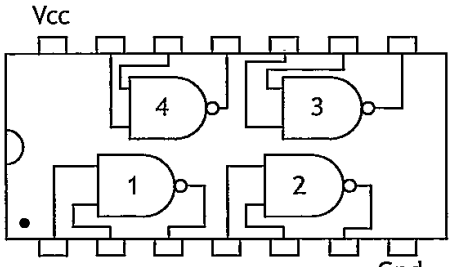
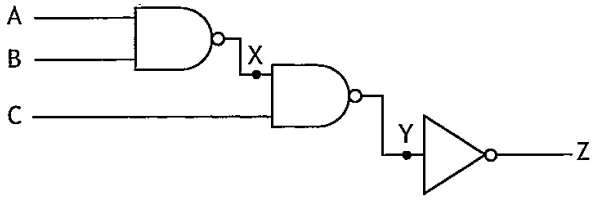
4. (continued)

(c) Using information from the data sheet, identify the **integrated circuit** (IC) shown. 1



7400 quad 2 input NAND gates

(d) Complete the truth table for the logic circuit shown. 3

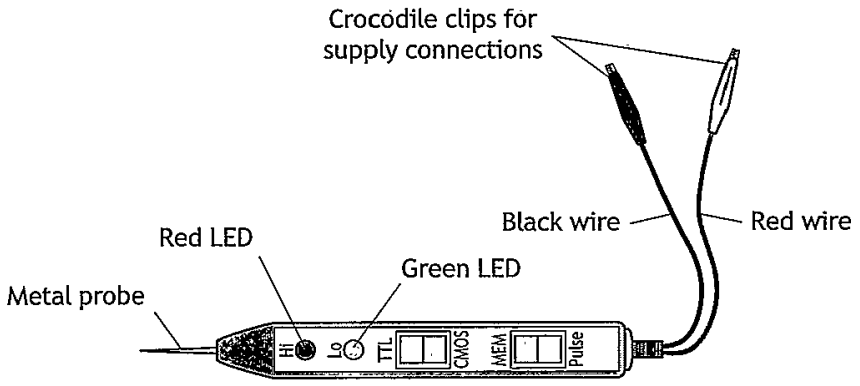


A	B	C	X	Y	Z
0	0	0	1	1	0
0	0	1	1	0	1
0	1	0	1	1	0
0	1	1	1	0	1
1	0	0	1	1	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	1	0	1	0

(An additional truth table, if required, can be found on *page 24*.)

MARKS | DO NOT WRITE IN THIS MARGIN

5. A logic probe is used to test the inputs and outputs of a 74 series logic chip.
The logic probe is set to TTL and pulse.



Describe how to connect and use the logic probe to test the inputs and outputs of the chip.
In your answer include how a logic 1 is detected. 3

- Connect the crocodile clips to the circuit's power ~~supply~~ supply. (black to negative, red to positive)

- Place the metal probe against the output you want to test.

- If the red LED flashes and an audible pulse is heard, the output is working. (logic 1)

[Turn over

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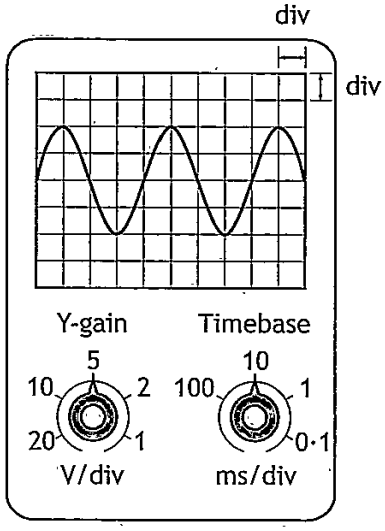
6. (a) The output from a signal generator is connected to the input terminals of an oscilloscope.

The trace is shown on the screen.

The Y-gain and timebase settings are also shown.



Determine the frequency of the signal. 3

Space for working and answer

$V = 2\text{ div} \times 5\text{V/div} = 10\text{V}$

$t = 4\text{ div} \times 10\text{ms/div} = 40\text{ms}$

$f = \frac{1}{T} \qquad f = \frac{1}{40}$

$f = 0.025\text{Hz}$

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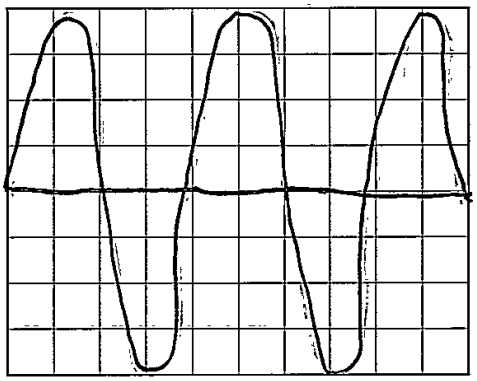
6. **(continued)**

(b) The peak voltage of the output signal from the signal generator is now **doubled.**

The frequency of the signal is unchanged.

The settings on the oscilloscope are unchanged.

Draw the new trace that would be shown on the screen. 1



(An additional diagram, if required, can be found on *page 24*.)

[Turn over

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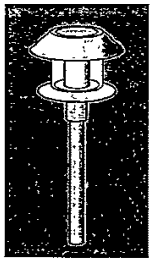
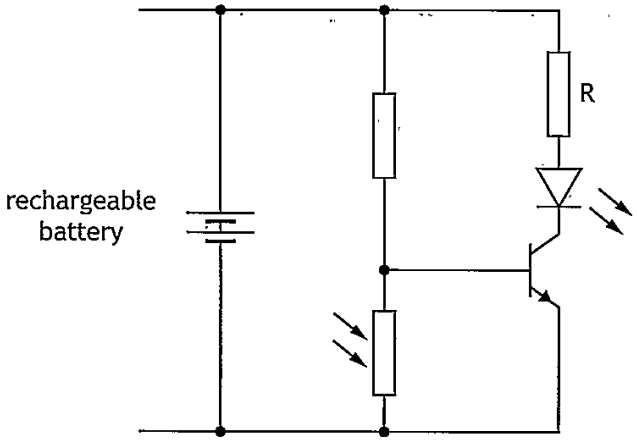
7. A high intensity LED is used as a garden light. The light turns on automatically when it becomes dark.



(a) The LED is switched on using the following circuit.



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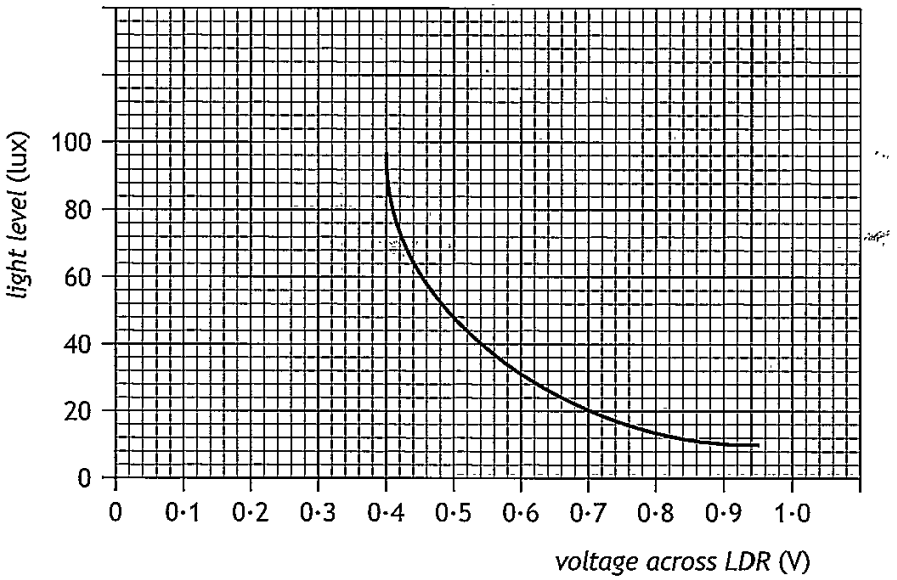
7. (a) (continued)

The graph shows the voltage across the LDR in this circuit for different light levels.



(i) For the LED to switch on, the voltage across the LDR must be at least 0·7 V.

Determine the light level at which the LED switches on. 1

20 lux

(ii) Explain the purpose of resistor R. 1

To protect the LED.

(iii) The manufacturer has used a bipolar transistor, as a MOSFET cannot be used in this circuit.

Explain why a MOSFET cannot be used in this circuit. 1

As a MOSFET runs on voltage rather than current, so it would stop working when the battery is low.

[Turn over

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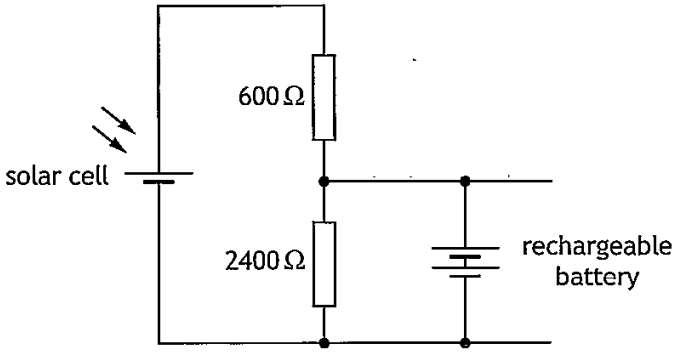
7. (continued)

(b) The light also contains a solar cell which charges the rechargeable battery during daylight hours.

Part of the circuit is shown.



At a particular light level, the voltage generated by the solar cell is 1·5 V.

Calculate the voltage across the rechargeable battery at this light level. **3**

Space for working and answer

$$V_2 = \frac{R_2}{R_1 + R_2} \times V_S$$

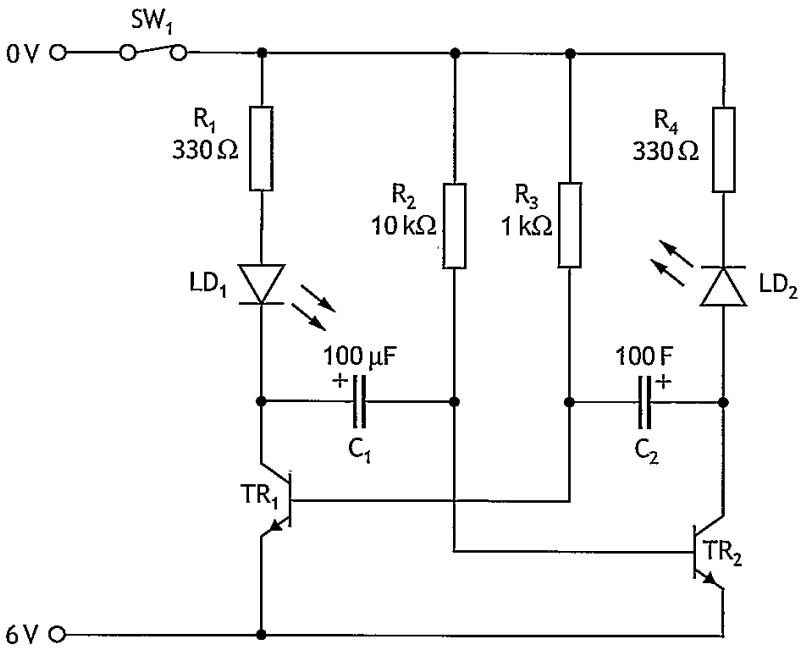
$$V_2 = \frac{2400}{600+2400} \times 1 \cdot 5$$

$$V_2 = 1.2\text{ V}$$

MARKS | DO NOT WRITE IN THIS MARGIN

8. When switched on, the circuit shown should have the LEDs alternately **flashing at the same rate.** However the student has made four errors.

Identify the **four** errors. 4



Error 1: [illegible] (C1 and C2 aren't equal.

Error 2: The power rails should be switched. (0V at the top, 6V at the bottom)

Error 3: LD2 is orientated incorrectly.

Error 4: R3 should be 10kΩ rather than 1kΩ.

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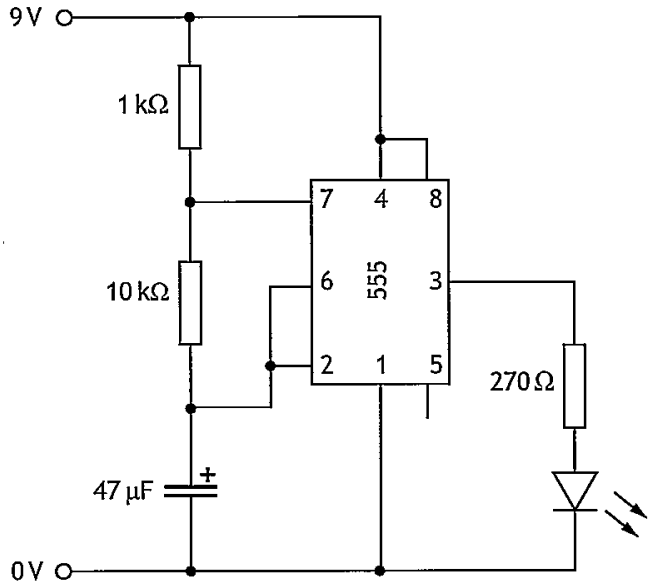
9. A student builds the circuit shown.



Using the information from two suppliers' catalogues shown on the opposite page, complete the costings sheet to produce the **lowest** cost for the circuit. **5**

Supplier	*Component*	*Product code*	*Cost (p)*
JIMSON	NE555	TC124	20
SWIFT	8 way DIL socket	SK-0080	10
SWIFT	LED 5 mm std	SC-0155	4
JIMSON	47 µF electrolytic capacitor	EC0799	14
JIMSON	270R	FR 9922	0.25
JIMSON	1K	FR 923	0.25
SWIFT	10K	EC-0182	1.5

DO NOT WRITE IN THIS MARGIN

9. (continued)

Supplier	SWIFT			
	Component	Description	Product code	Cost
Integrated circuits	LM555CM	timers	IC-0283	45p
	NE555	timers	IC-0254	32p
	NE556	timers	IC-0216	25p
	8 way dil	ic socket	SK-0080	10p
Semi-conductors	LED	5 mm std red	SC-0155	4p
	LED	10 mm std red	SC-0177	10p
Electrolytic capacitors	10 µF	16 V	CP-0555	10p
	47 µF	16 V	CP-0566	18p
	47 µF	6 V	CP-0588	10p
	47 µF	5 V	CP-0599	8p
Resistors	220R	0·25 W carbon film 5%	EC-0159	0·5p
	270R	0·25 W carbon film 5%	EC-0161	0·5p
	1K	0·25 W carbon film 5%	EC-0175	0·5p
	10K	0·25 W carbon film 5%	EC-0182	1·5p
	100K	0·25 W carbon film 5%	EC-0198	3p

Supplier	JIMSON			
	Component	Description	Product code	Cost
Integrated circuits	LM555CM	timers	TC 123	90p
	NE555	timers	TC 124	20p
	NE556	timers	TC 125	80p
	8 way dil	ic socket	SK 099	50p
Semi-conductors	LED	5 mm std red	LD345	12p
	LED	10 mm std red	LD346	20p
Electrolytic capacitors	10 µF	16 V	EC 798	10p
	47 µF	16 V	EC 799	14p
	47 µF	6 V	EC 800	10p
	47 µF	5 V	EC 801	8p
Resistors	220R	0·25 W carbon film 5%	FR 921	0·25p
	270R	0·25 W carbon film 5%	FR 922	0·25p
	1K	0·25 W carbon film 5%	FR 923	0·25p
	10K	0·25 W carbon film 5%	FR 924	2p
	100K	0·25 W carbon film 5%	FR 925	5p

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10. An engineer designs a system to control the temperature within a greenhouse.

The system includes a sensor which measures the temperature within the greenhouse.

If the temperature exceeds 24 °C this turns on a motor to open a window.

An LED indicator lights when the window is open.

There is also a manual switch to turn the whole system on and off.

Selecting from the elements given, draw a block diagram of an electronic solution for this system.

On your diagram, clearly indicate the input, process and output sections of your solution. **6**

AND gate	NOR gate	NOT gate	Window motor (requires a logic 0 to turn the motor on)	Manual switch circuit (logic 1 when closed)
OR gate	XOR gate	LED circuit (requires a logic 1 to turn the LED on)	Temperature sensor (logic 1 when temperature is greater than 24 °C)	
Light sensor (logic 1 when light)				

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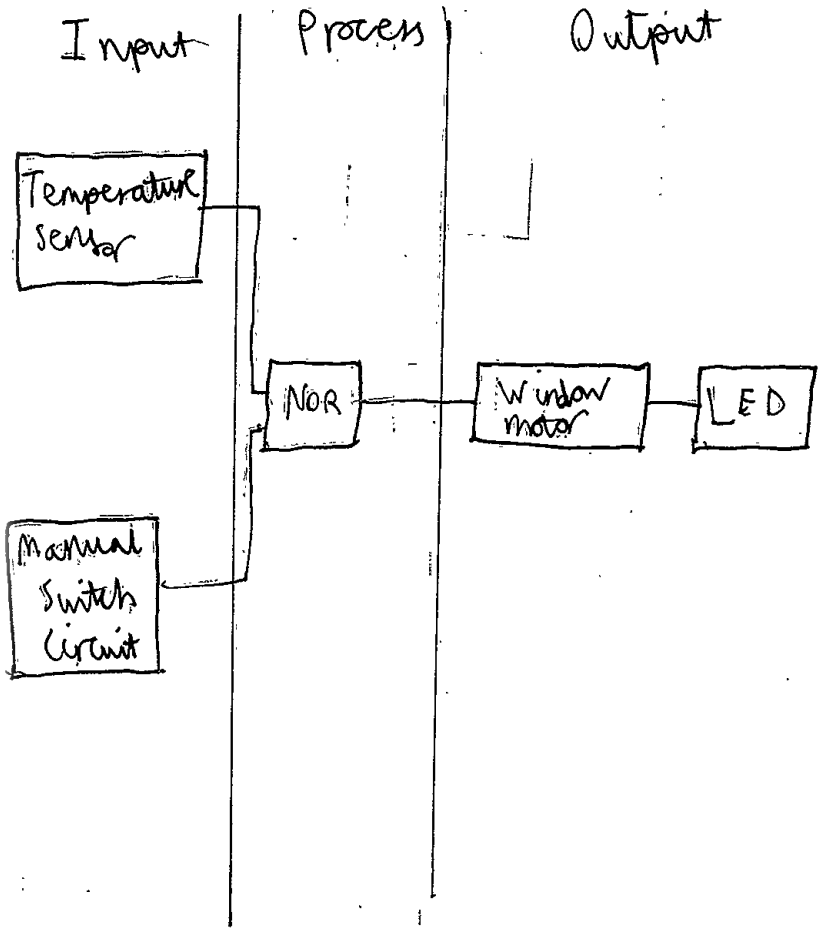
10. (continued)



[Turn over for next question

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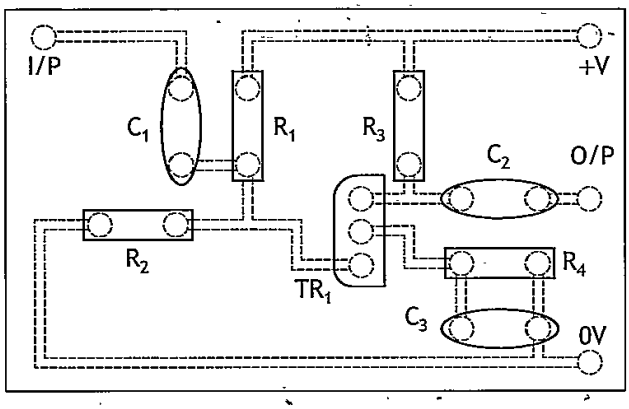
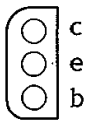
11. The following PCB layout shows a circuit with the following component data.



Component data

R_1 — carbon film 82K 0·25 W
R_2 — carbon film 10K 0·25 W
R_3 — carbon film 8K2 0·25 W
R_4 — carbon film 1K 0·25 W
C_1 — 0·1 µF
C_2 — 0·1 µF
C_3 — 10 µF
TR_1 — BC182 npn bipolar



TR_1 pin connections

Draw a circuit diagram for this circuit. 6
Each component must be labelled.

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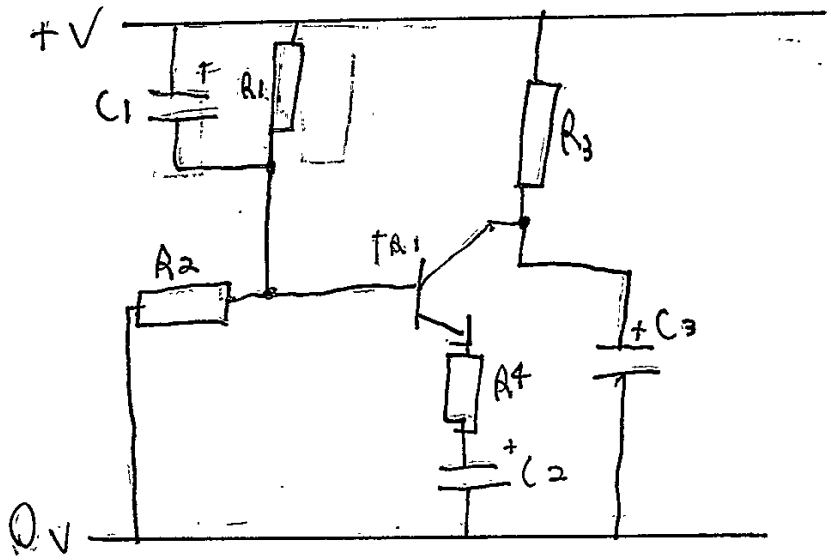
11. (continued)



[END OF QUESTION PAPER]

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional truth table for question 4 (a)

A	B	Output
0	0	
0	1	
1	0	
1	1	

Additional truth table for question 4 (d)

A	B	C	X	Y	Z
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

Additional diagram for question 6 (b)