Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C490UA0-1

O20-C490UA0-1

TUESDAY, 3 NOVEMBER 2020 – AFTERNOON

ELECTRONICS – Component 1
Discovering Electronics

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**12**	
3.	**12**	
4.	**8**	
5.	**6**	
6.	**11**	
7.	**11**	
8.	**5**	
9.	**7**	
Total	**80**	

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ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **5**.

INFORMATION SHEET

This information may be of use in answering the questions.

Resistor Colour Codes

Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Grey	8
Yellow	4	White	9

The fourth band colour gives the tolerance as follows:

GOLD ± 5%

SILVER ± 10%

Resistors E24 series values

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

Useful equations

$$P = \frac{V^2}{R} \qquad G = 1 + \frac{R_F}{R_1}$$

$$V_{OUT} = \frac{R_2}{R_1 + R_2} V_{IN} \qquad G = -\frac{R_F}{R_{IN}}$$

$$I_D = g_M(V_{GS} - 3) \qquad V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \cdots\right)$$

$$I_C = h_{FE} I_B \qquad T = 1.1RC$$

$$\overline{A + B} = \overline{A}.\overline{B} \qquad f = \frac{1}{T}$$

$$\overline{A.B} = \overline{A} + \overline{B} \qquad f = \frac{1.44}{(R_1 + 2R_2)C}$$

$$G = \frac{V_{OUT}}{V_{IN}} \qquad \frac{T_{ON}}{T_{OFF}} = \frac{R_1 + R_2}{R_2}$$

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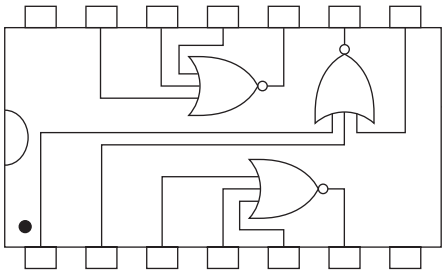
Answer **all** *questions.*

1. *(a)* The diagram shows the pin out for an IC (integrated circuit).



(i) Label pin 1 and pin 14 on this IC. [1]

(ii) How many logic input pins **in total** are there on this IC? ..... [1]

(iii) How many logic output pins **in total** are there on this IC? ..... [1]

(iv) Name the type of logic gate found on this IC. ..... [1]

(b) Draw the logic gate symbol for:

(i) an OR gate [1]

(ii) a NAND gate. [1]

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(c) Complete the following truth tables for:

(i) an AND gate [1]

B	A	Q
0	0	
0	1	
1	0	
1	1	

(ii) a NOR gate. [1]

B	A	Q
0	0	
0	1	
1	0	
1	1	

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2. *(a)* For each of the sub-systems below state if they are input, process or output sub-systems:

(i) Buzzer unit .....

(ii) Switch unit .....

(iii) Transistor switch unit .....

(iv) Comparator ..... [4]

(b) The Temperate House at Kew Gardens in London is the world's biggest Victorian glasshouse. It has just been refurbished and is home to over 10 000 plants. In order to maintain the correct conditions for the plants an automatic watering system is needed. The specification is as follows:

SPECIFICATION

- The watering system should operate only at night.
- The watering system should operate only when the soil is dry.
- Water flow is controlled by a solenoid valve requiring a current of 4 A to operate it.
- The water should be turned on for a fixed period of 15 minutes.

The following sub-systems are available.

latch unit **OR gate** **thyristor** **light sensing unit** **solenoid unit**

moisture sensing unit **temperature sensing unit** **AND gate**

NAND gate **MOSFET** **comparator** **NOT gate** **delay unit**

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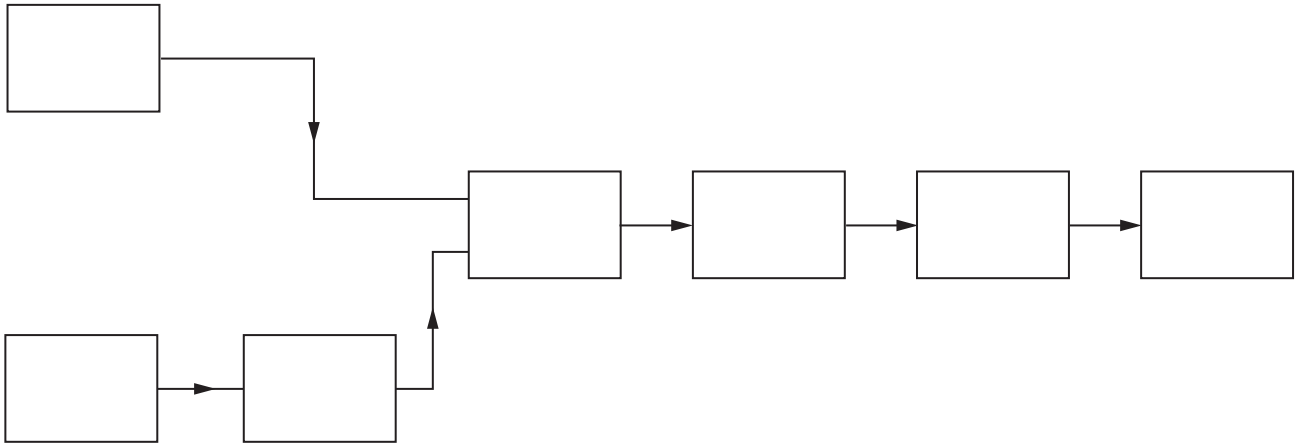
The sensors behave as follows:

- The moisture sensor outputs logic 1 when dry.
- The light sensor outputs logic 0 in the dark.
- The temperature sensor outputs logic 1 when hot.

Select the correct sub-systems to complete the block diagram design.



[7]

(c) Which of the following can be used for the delay unit?

Astable **Bistable** **Monostable**

Answer ..... [1]

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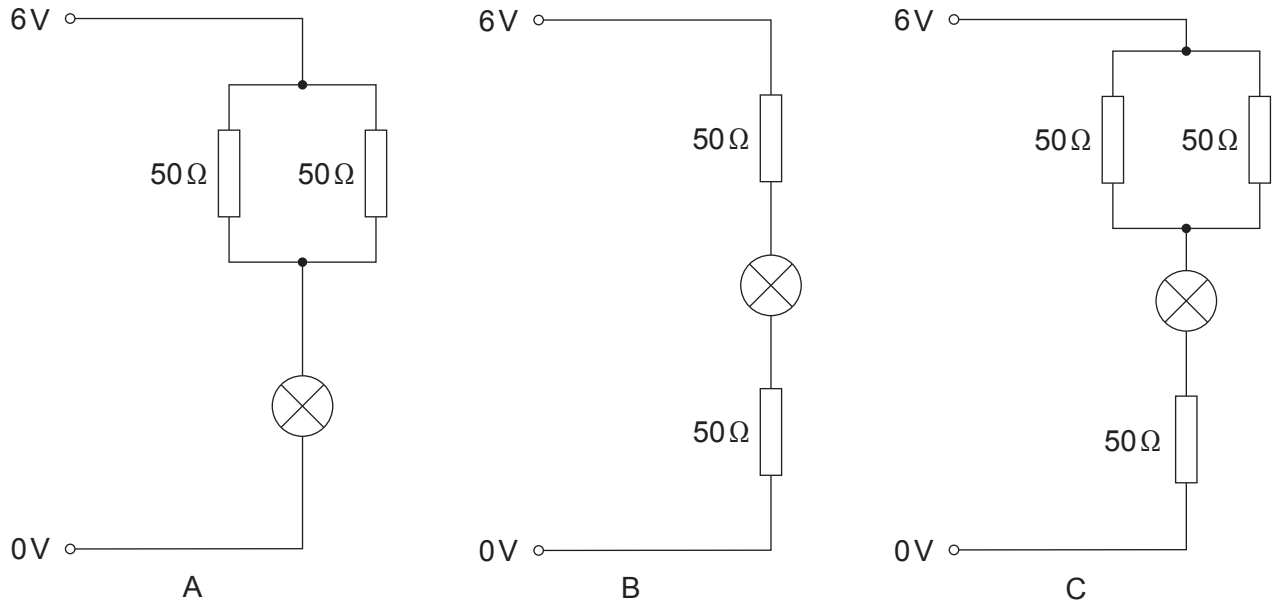
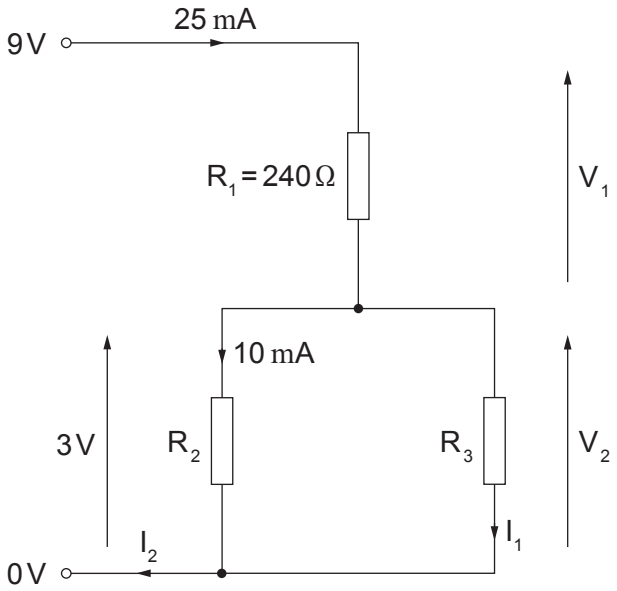
3. *(a)* The following circuits contain identical power supplies and lamps with a different combination of resistors.



In which of the three circuits will the lamp be dimmest? ..... [1]

(b) The diagram shows part of a circuit.



(i) Determine the values of the following: [4]

V_1 = ...

I_1 = ...

V_2 = ...

I_2 = ...

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(ii) Calculate the value of R_2. [3]

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(c) What is the colour code on resistor R_1 which has a tolerance of ±5%? [4]

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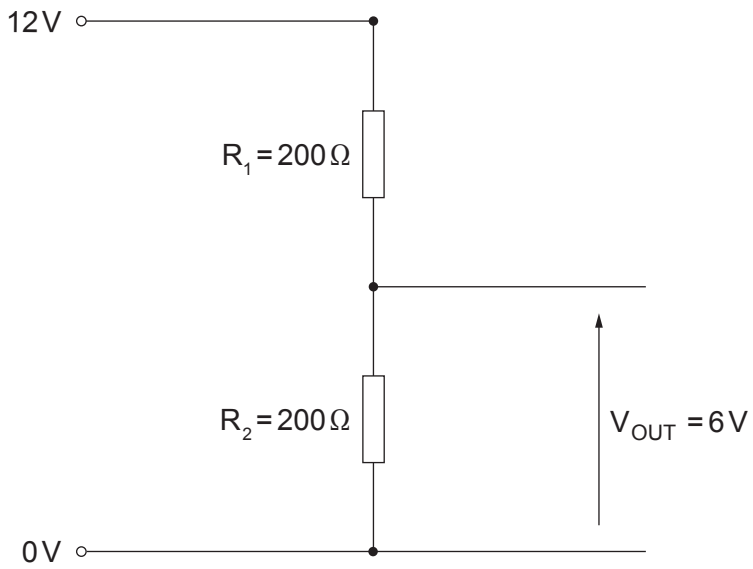
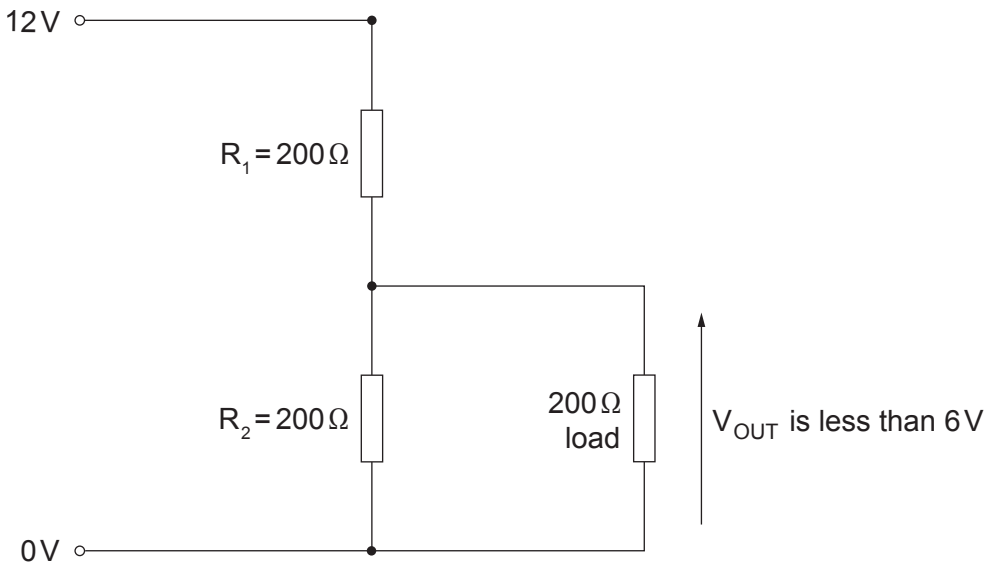
4. A design for a simple 6 V power supply to operate from a 12 V battery is shown below.



The circuit is tested by connecting a 200 Ω load across the output.
The output voltage is now less than 6 V.



(a) Explain why the output voltage is less than 6 V when the load is connected. [2]

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(b) Calculate the new output voltage. [4]

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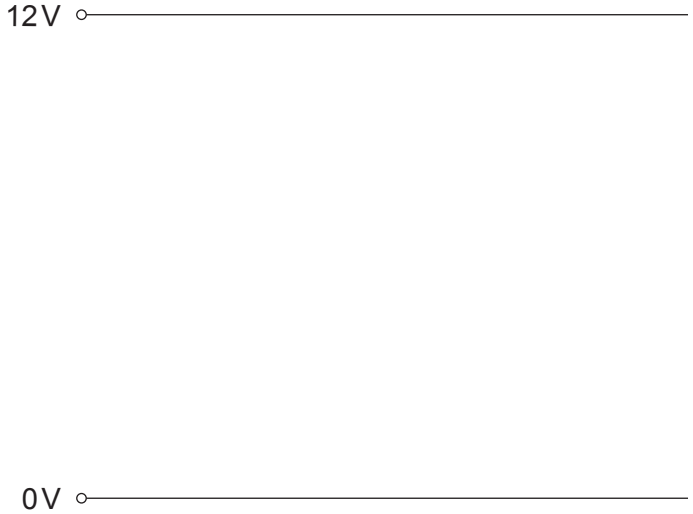
(c) Draw a circuit diagram below to provide a regulated power supply for the 200Ω load resistor using a 6.1 V zener diode. [2]



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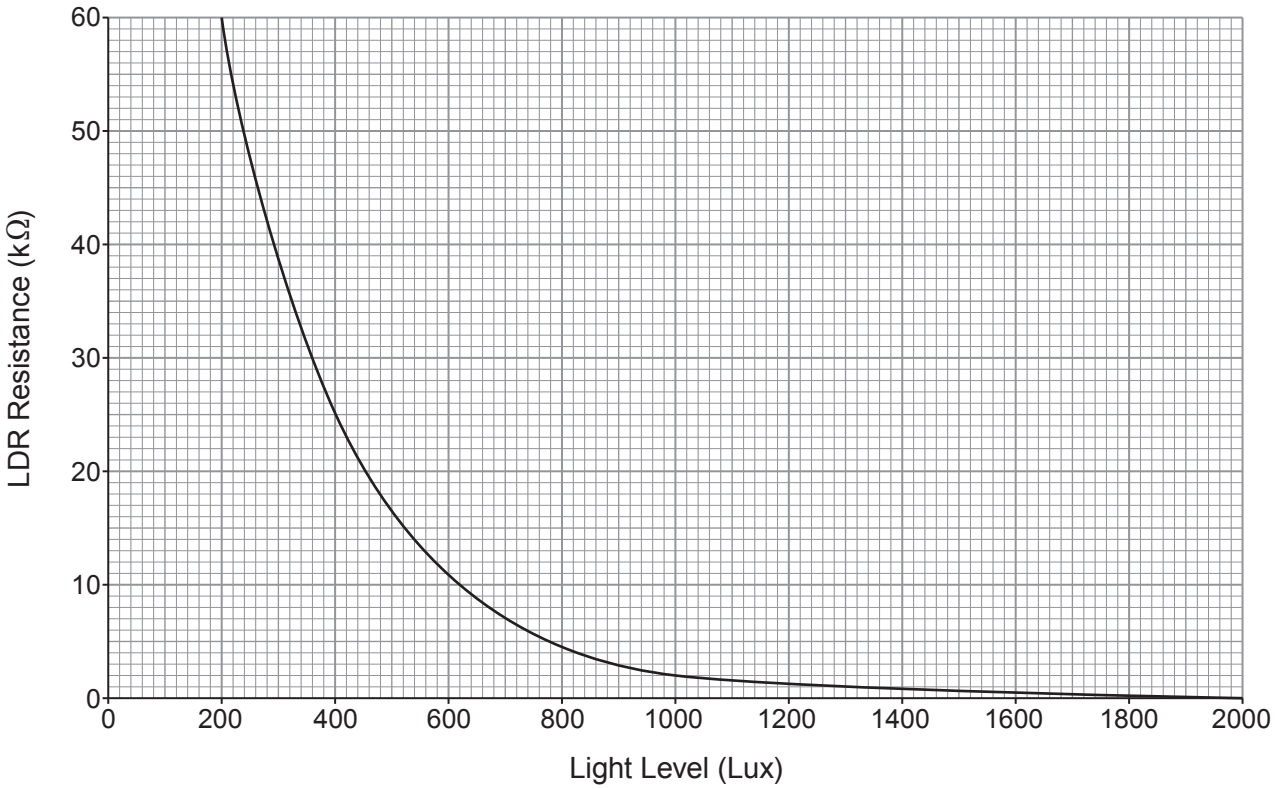
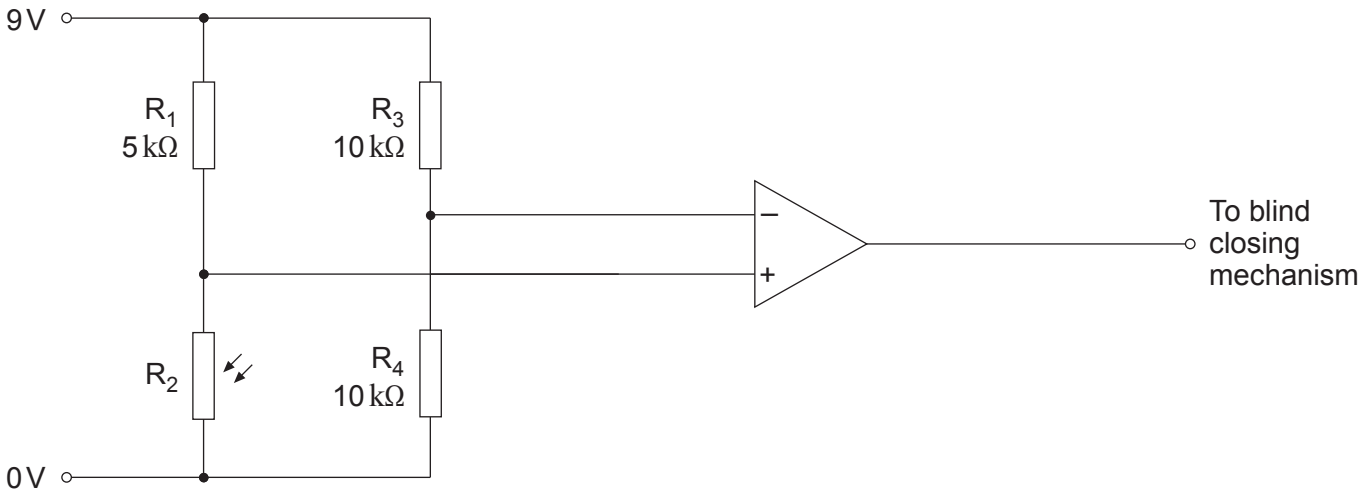
5. A student has designed a system to close a ceiling blind in a conservatory when it becomes too bright outside.

The characteristic of the LDR used in the design is shown below.



The blind should close when the light level is 400 lux and the comparator output is high.
A solution is shown below.



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Evaluate the circuit design and determine whether it is a suitable design and describe any modifications required to meet the specification. [6 QER]

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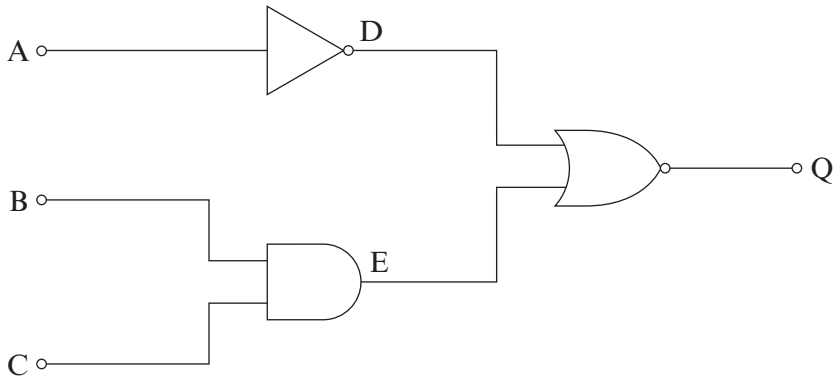
6. The diagram below shows a logic system.



(a) Write down in terms of the inputs A, B and C the Boolean expressions for: [3]

(i) Output D .....

(ii) Output E .....

(iii) Output Q .....

(b) Complete the following truth table for this logic system. [3]

C	B	A	D	E	Q
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

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(c) (i) Redraw the logic circuit using NAND gates only. [3]

(ii) Cross out all redundant gates on the diagram above. [2]

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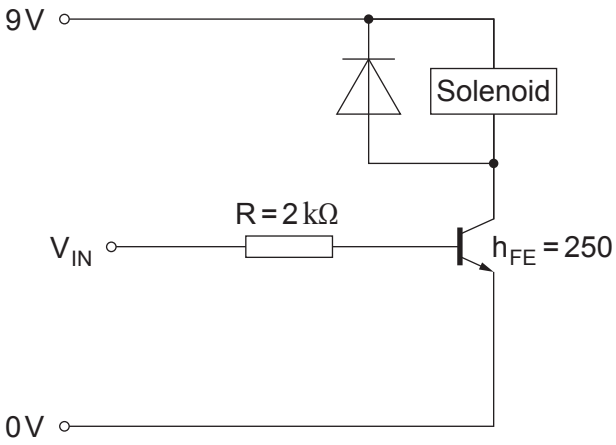
7. The following part of a circuit diagram shows an output driver circuit based on a transistor switch.



The input voltage V_{IN} is 1.5 V. The transistor is just saturated.

(i) Calculate the voltage across the 2 kΩ resistor. [2]

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(ii) Calculate the current flowing through the 2 kΩ resistor. [3]

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(iii) Calculate the collector current. [3]

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(iv) Calculate the power dissipated in the solenoid. [3]

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8. A hotel manager wants to operate strict control over its car park and has commissioned the installation of an automatic entry and exit barrier system. The specification is as follows:

- The car park has 100 parking spaces.
- A ticket is issued on entry and then checked on exit.
- If the car park is full, then a 'Car Park Full' sign is to be lit.

A partly completed flowchart is shown opposite. The list of statements below are missing from the flowchart. After each statement write the letter from the flowchart to indicate where each statement should appear. [5]

Flowchart statement	**Position on Flowchart**
Raise entrance barrier	.....
Is Count = 100?	.....
Issue ticket	.....
Count = Count –1	.....
Is car present at exit?	.....

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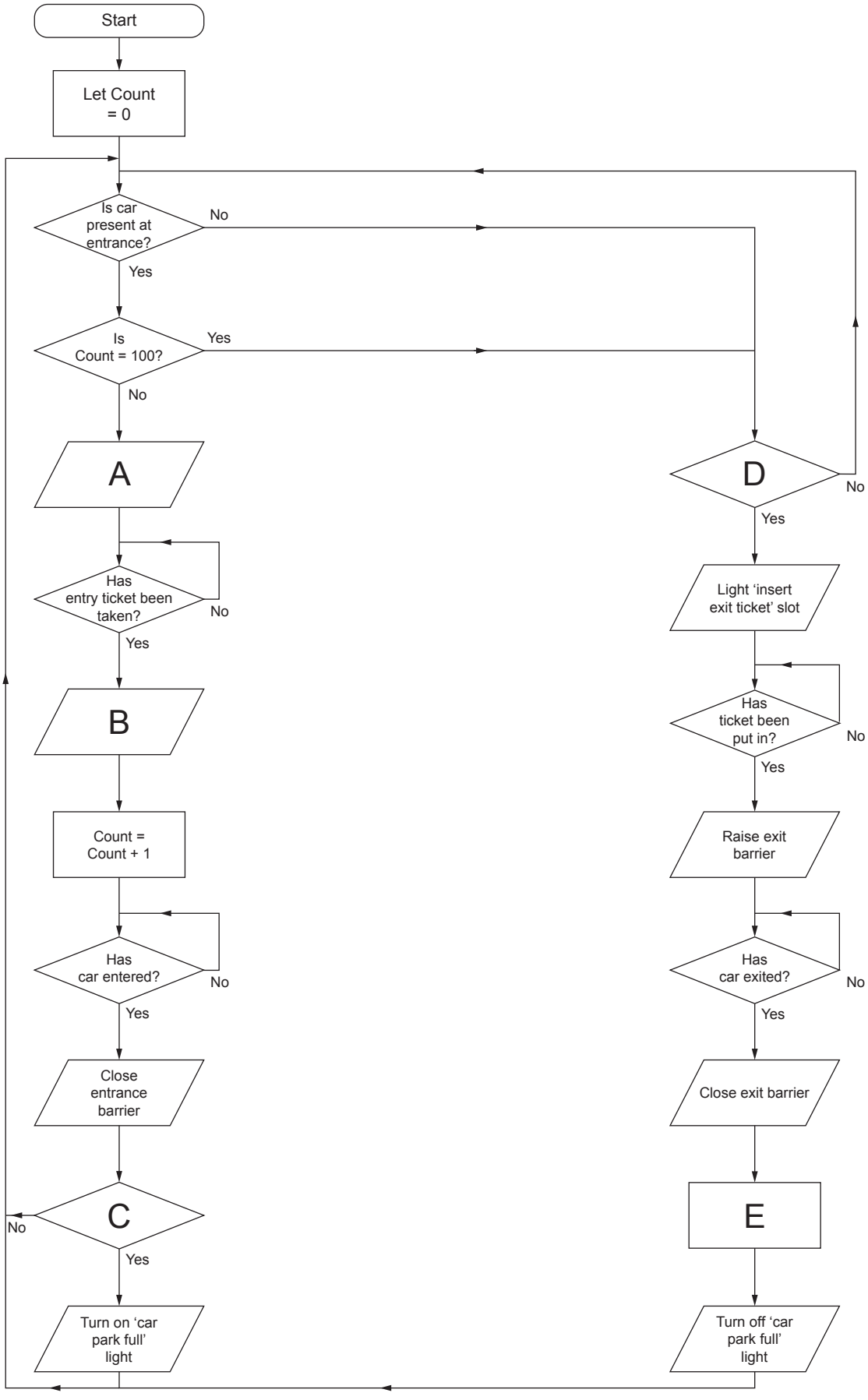

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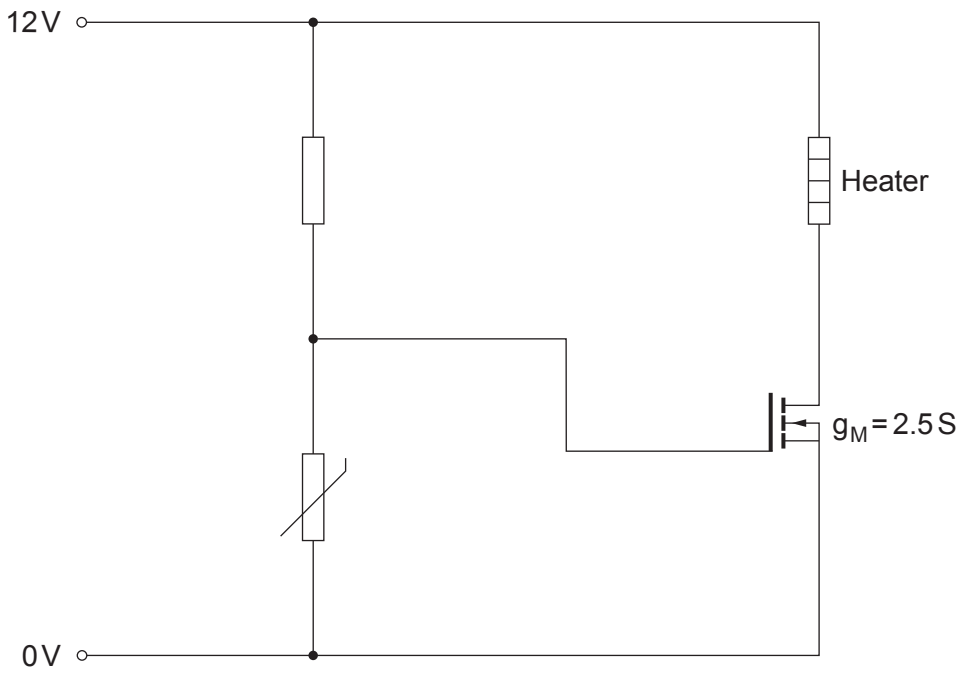
9. A MOSFET is a device that can be used to switch on high current loads. The following circuit shows the MOSFET being used to control a heater.



(a) The MOSFET is just saturated when the voltage across the thermistor is 9V. Calculate the current in the heater. [3]

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(b) After building the circuit it did not work correctly. Near the temperature when the heater should switch on, the heater kept switching on and off.

(i) Draw a modified circuit showing how this can be prevented. [2]

(ii) Explain how your modifications make the circuit work correctly. [2]

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