Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C490UA0-1

Z22-C490UA0-1

FRIDAY, 27 MAY 2022 – AFTERNOON

ELECTRONICS – Component 1

Discovering Electronics

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**9**	
3.	**13**	
4.	**11**	
5.	**12**	
6.	**13**	
7.	**13**	
Total	**80**	

C490UA01
01

ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

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 **4**(b).

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

$$P = \frac{V^2}{R}$$

$$V_{OUT} = \frac{R_2}{R_1 + R_2} V_{IN}$$

$$I_D = g_M(V_{GS} - 3)$$

$$I_C = h_{FE} I_B$$

$$\overline{A + B} = \overline{A}.\overline{B}$$

$$\overline{A.B} = \overline{A} + \overline{B}$$

$$G = \frac{V_{OUT}}{V_{IN}}$$

$$G = 1 + \frac{R_F}{R_1}$$

$$G = -\frac{R_F}{R_{IN}}$$

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

$$T = 1.1RC$$

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

$$f = \frac{1.44}{(R_1 + 2R_2)C}$$

$$\frac{T_{ON}}{T_{OFF}} = \frac{R_1 + R_2}{R_2}$$

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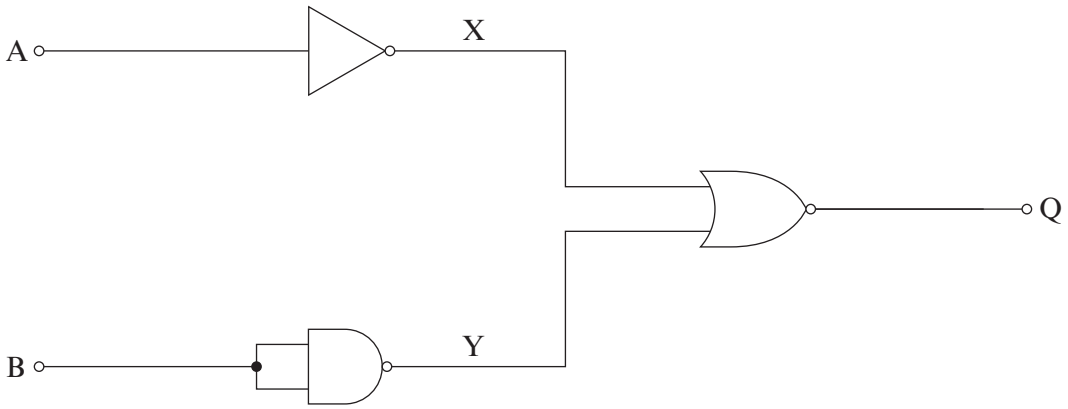
Answer **all** questions.

1. (a) Draw the circuit symbol for each of the following logic gates:

(i) AND gate (ii) OR gate [2]

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



B	A	X	Y	Q
0	0			
0	1			
1	0			
1	1			

(ii) Which single logic gate could produce the same output Q? [1]

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(c) Which logic gate has an output of logic 0 **only** when both inputs are at logic 1? [1]

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(d) Which of the **two** following Boolean equations are correct? **Tick (✓)** both correct answers. [2]

$\overline{X + Y} = \overline{X}.\overline{Y}$ ☐

$\overline{X + Y} = \overline{X}.\overline{Y}$ ☐

$\overline{X + Y} = \overline{X} + \overline{Y}$ ☐

$\overline{X.Y} = \overline{X}.\overline{Y}$ ☐

$\overline{X.Y} = \overline{X} + \overline{Y}$ ☐

C490UA01
05

9

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2. The truth table for a logic system is shown below:

B	A	X	Y	Q
0	0	1	0	1
0	1	0	0	0
1	0	0	0	0
1	1	0	1	1

(a) Draw the logic system that will produce the output Q using **only** AND, OR and NOT gates. [3]

A

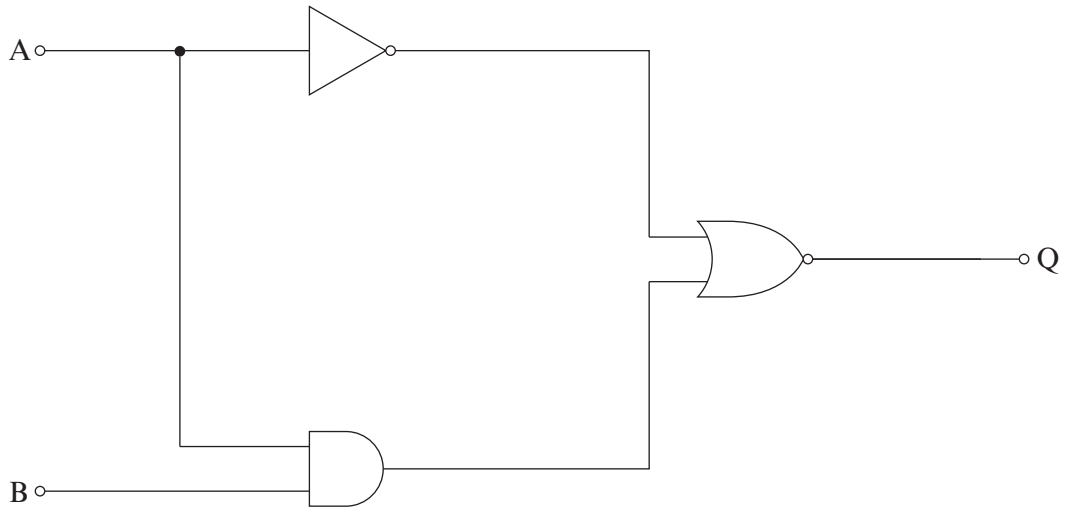
X

Q

B

Y

(b) A different logic system is shown below.



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

(ii) **Cross out** all redundant NAND gates. [2]

(c) Give **one** advantage of converting logic systems to NAND gates. [1]

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C490UA01
07

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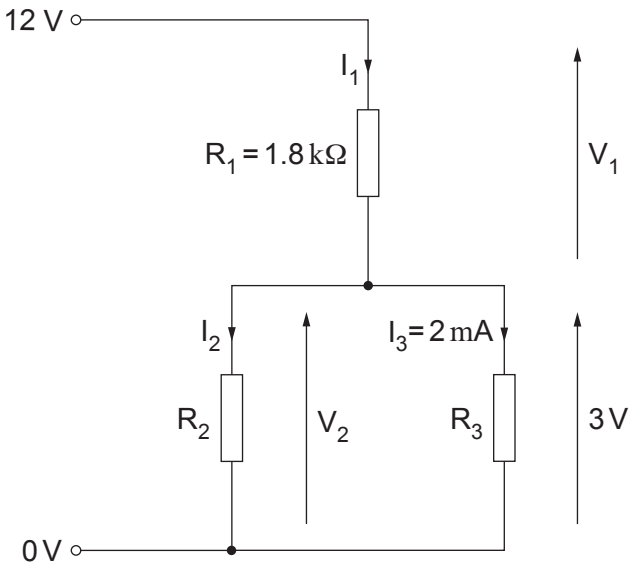
3. The circuit diagram shows a network of resistors connected to a 12 V power supply.



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

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(b) Calculate the value of:

(i) V_1 [2]

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(ii) I_1 [4]

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(iii) I_2 [2]

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(c) Determine the value of V_2. [1]

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13

C490UA01
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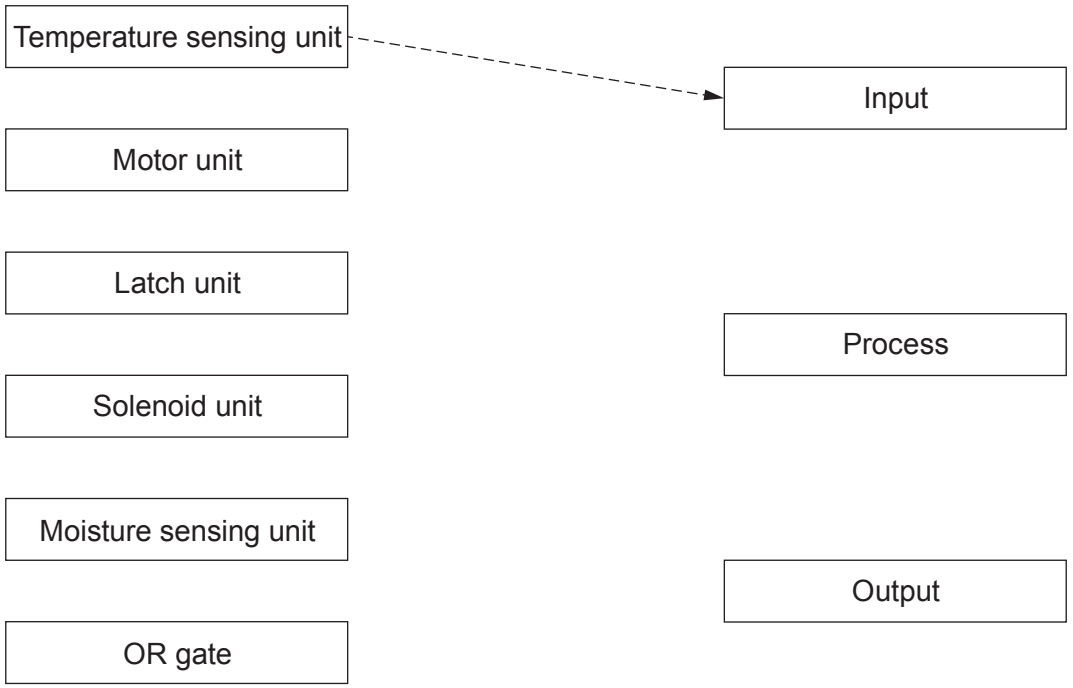
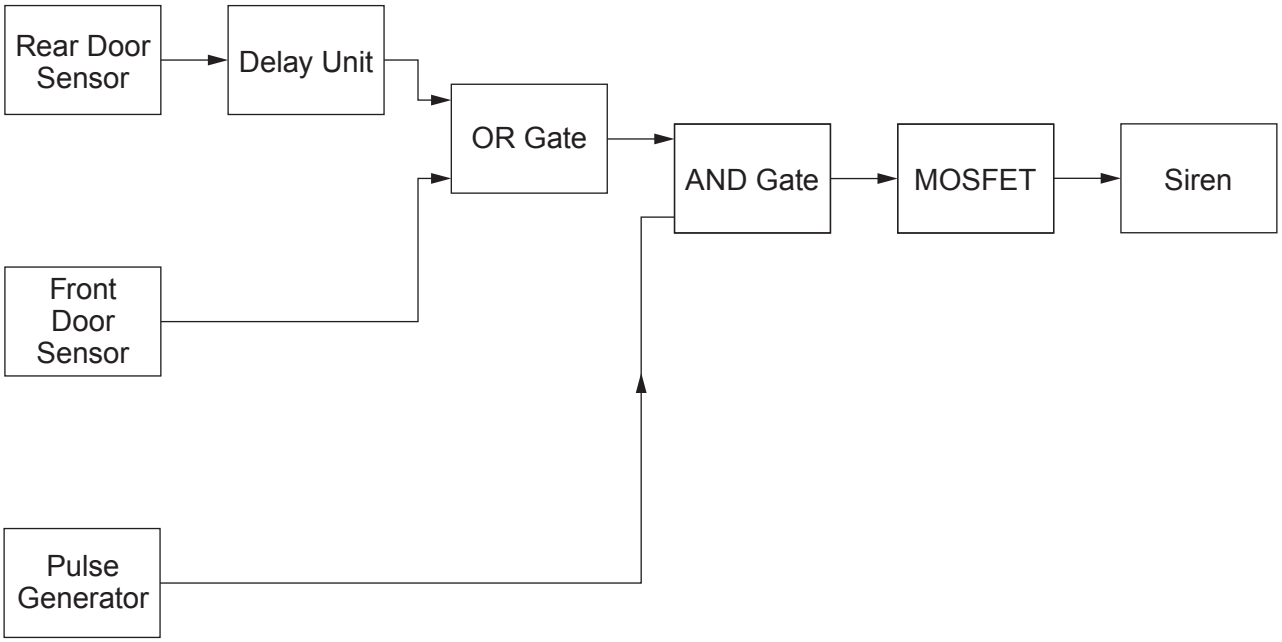
4. All electronic systems can be broken down into three main system blocks – Input, Process and Output.

(a) Link the units on the left to their system block on the right. One has been done for you. [5]



(b) The following block diagram shows a burglar alarm designed to protect a small business property.



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The specification for the alarm is as follows:

- There are two entry doors to the property to be protected.
- When the front door is opened a 30 second delay should be started to allow the owner time to turn off the alarm when entering the building before the alarm is triggered.
- When the rear door is opened the alarm should be triggered immediately.
- The alarm siren pulses on and off continually once triggered.
- If either door is closed after being opened the alarm should continue to sound.

Evaluate the design against the specification and if necessary, suggest any modifications needed to meet the specification fully. [6 QER]

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11

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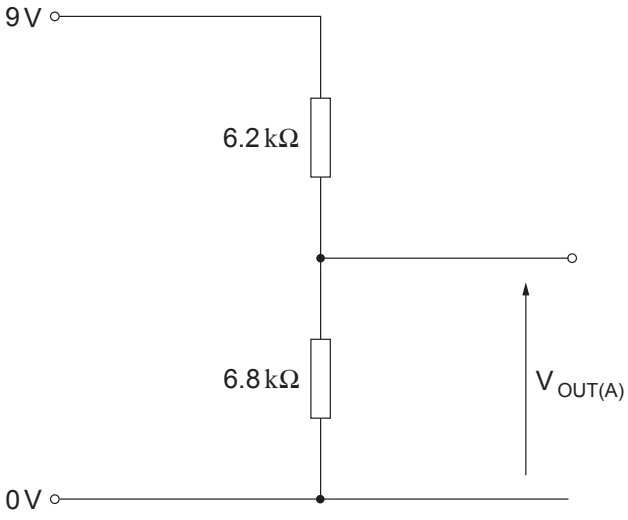
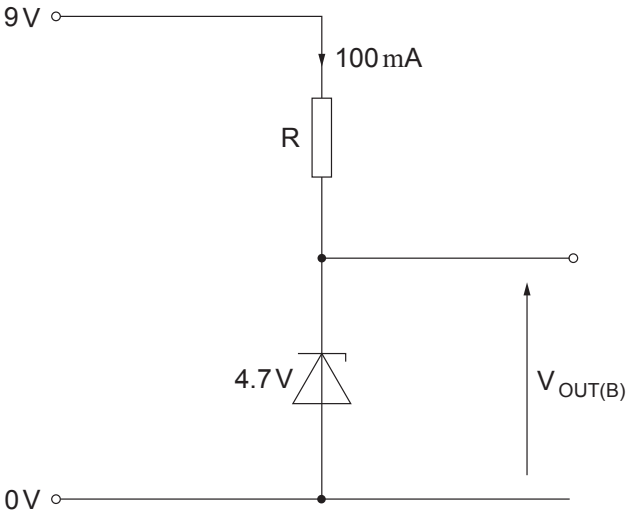
5. Two designs for a simple power supply to operate from a 9 V battery are shown below. The holding current for the zener diode in circuit B is 8 mA.



Circuit A



Circuit B

(a) Calculate the output voltage $V_{OUT(A)}$. [3]

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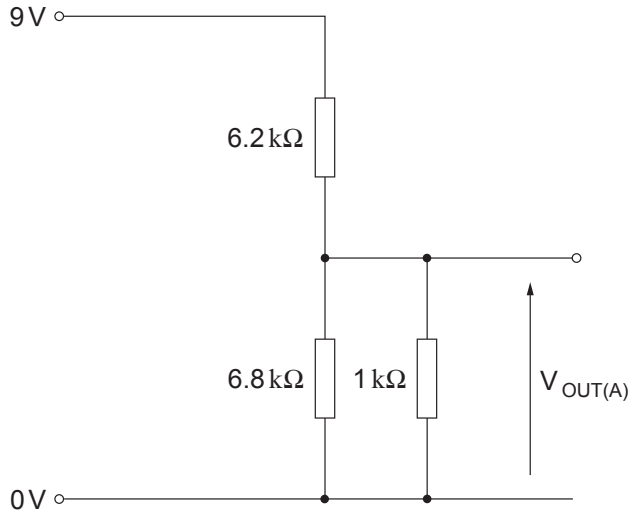
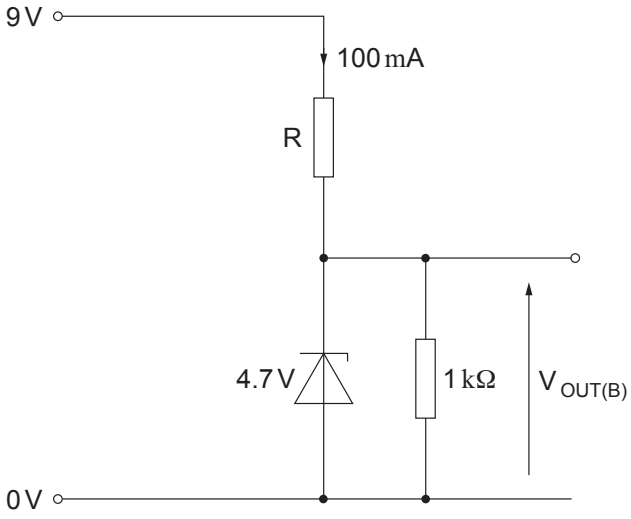
(b) What is the output voltage $V_{OUT(B)}$? ..... [1]

(c) A 1 kΩ load resistor is now connected across the output of these power supplies.



Circuit A



Circuit B

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Calculate the new output voltages $V_{OUT(A)}$, and $V_{OUT(B)}$. [6]

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(d) The load resistance is now changed to 500 Ω. **Circle** how this would affect the output voltage in each circuit. [2]

Circuit A:

equals 0 V decreases stays the same increases equals 9 V

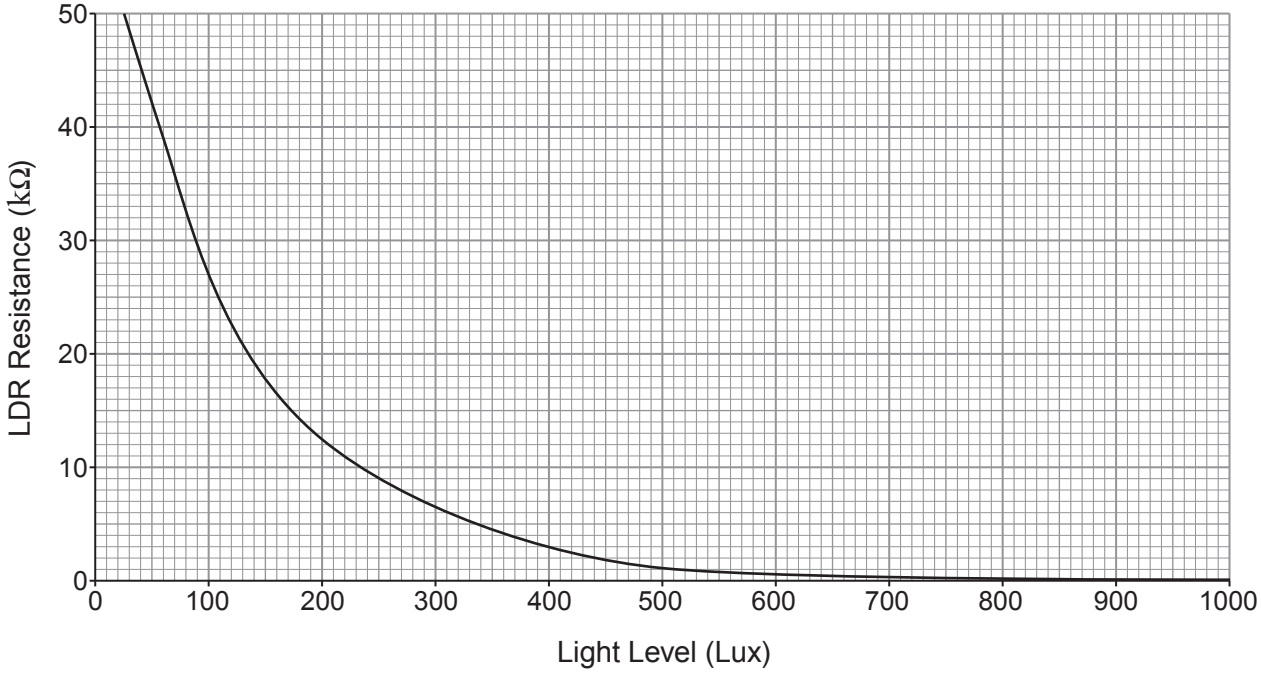
Circuit B:

equals 0 V decreases stays the same increases equals 9 V

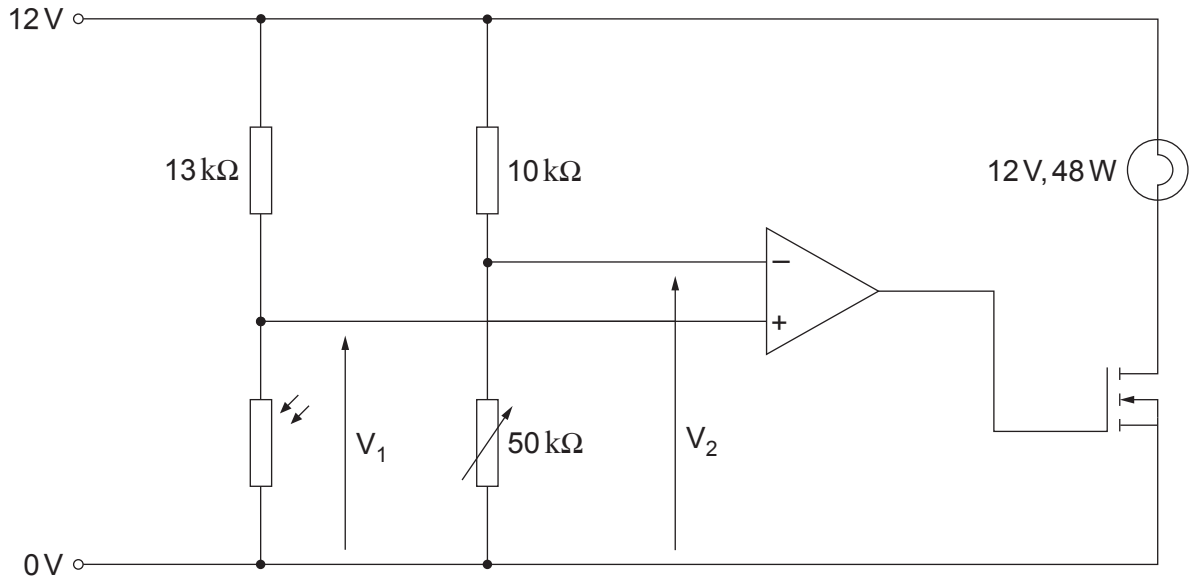
12

6. A student has designed a system to switch on a light in a shop window when it becomes dark.

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



The light switches on when the light level drops to 60 lux.



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(a) Use the LDR characteristic to determine the resistance of the LDR at 60 lux. [1]

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(b) Calculate the value of V_1 at 60 lux. [3]

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(c) What value of V_2 ensures that the light comes on when the light level falls to 60 lux? [1]

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(d) Calculate the current flowing through the light when it is operating at the rated value shown on the circuit diagram. [4]

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(e) The MOSFET just saturates when the gate voltage is 8 V. Calculate the value of g_M for the MOSFET. [4]

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13

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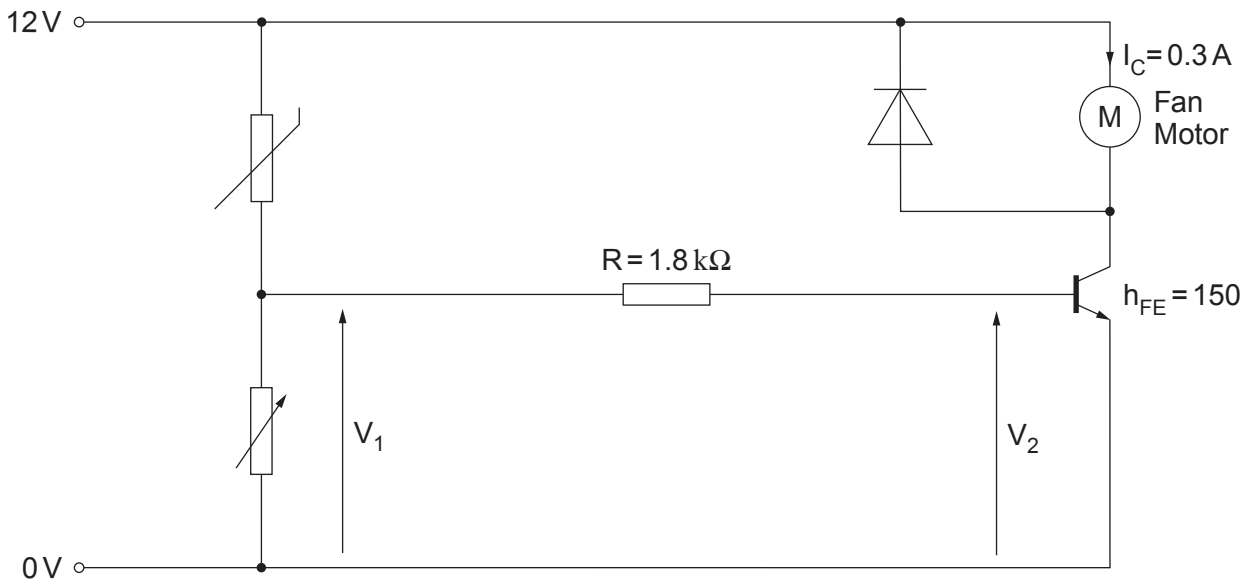
7. The following diagram shows the circuit for a temperature controlled fan.



The transistor is **just saturated** and the current through the fan motor is 0.3 A.

(a) Calculate the power dissipated in the fan motor. [3]

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(b) (i) Calculate the current flowing through the 1.8 kΩ resistor. [4]

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(ii) Calculate the voltage across the 1.8 kΩ resistor. [3]

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(c) What is the value of V_2? [1]

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(d) Calculate the minimum value of V_1 that will ensure the transistor is just saturated. [2]

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13

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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