GCSE – NEW

C490UA0-1

WEDNESDAY, 5 JUNE 2019 – MORNING

ELECTRONICS – Component 1

Discovering Electronics

1 hour 30 minutes plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 0 _____

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	8	
2.	11	
3.	13	
4.	11	
5.	11	
6.	9	
7.	6	
8.	11	
Total	80	

ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

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 7.

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

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

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

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

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

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

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

$$I_C = h_{FE} I_B$$

$$T = 1.1RC$$

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

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

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

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

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

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

Answer ALL questions.

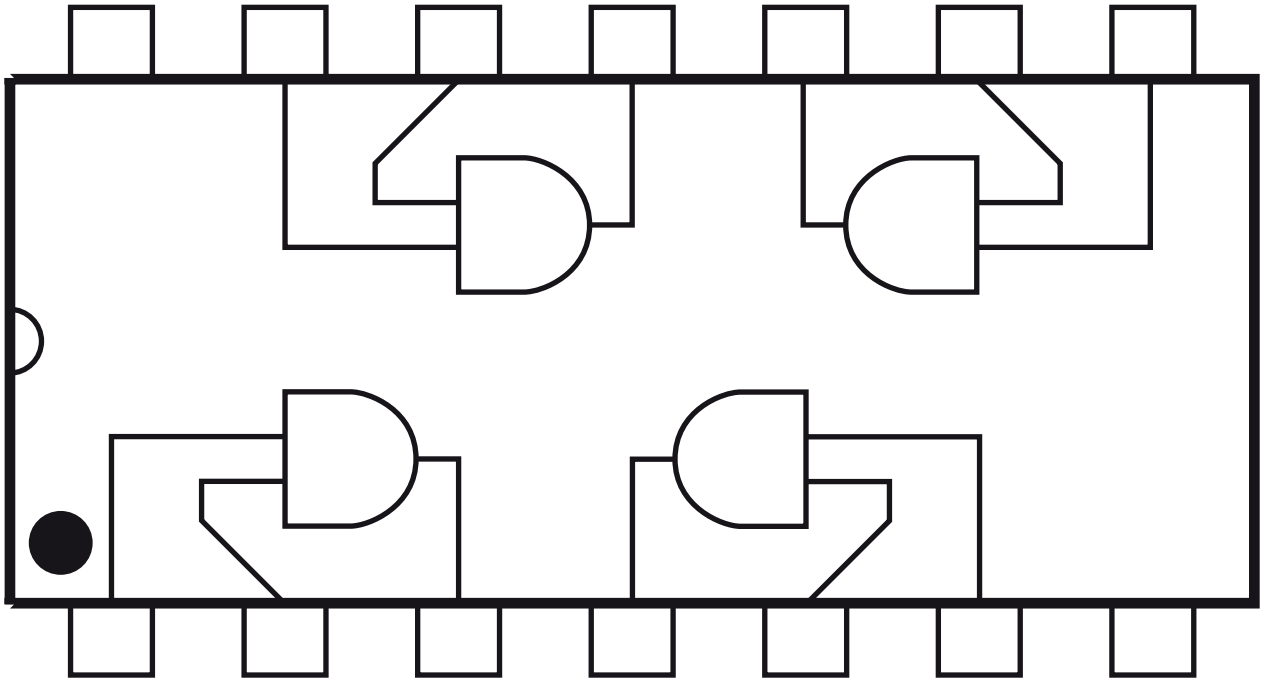
1(a) **The diagram opposite shows the pin out for an IC (integrated circuit).**

(i) **Label pin 6 on this IC. [1]**

(ii) **How many logic gates are there on this IC? [1]**

(iii) **How many inputs does each gate have? [1]**

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



1(b) **For each of the following truth tables name the logic gate and draw the symbol for the logic gate named.**

(i)

B	A	Q
0	0	1
0	1	1
1	0	1
1	1	0

Name the logic gate [1]

Draw the symbol for the logic gate named. [1]

1(b)(ii)

B	A	Q
0	0	0
0	1	1
1	0	1
1	1	1

Name the logic gate [1]

Draw the symbol for the logic gate named. [1]

2(a) Large electronic systems are broken down in the design stage into three sub-system categories:

– sensing units,

– signal processing,

– output devices.

For example, a buzzer is an OUTPUT sub-system.

Here are five other sub-systems:

DELAY UNIT

MOTOR UNIT

OR GATE

TEMPERATURE SENSING UNIT

COMPARATOR UNIT

2(a) Complete the table by adding the name of each sub-system on page 9 in the correct column. [3]

SENSING SUB-SYSTEMS	SIGNAL PROCESSING	OUTPUT SUB-SYSTEMS
		buzzer unit

2(b) **A large house in the country has a long path leading to the front door. A system is required to turn on a set of LED lights to illuminate the path for visitors.**

SPECIFICATION

- **The lighting system should only operate if it is dark.**

- **The lighting system should be operated either at the front door or when someone opens the gate.**

- **The LED lights should remain on for a fixed period of 3 minutes and then switch off automatically, until they are switched on again.**

The following sub-systems are available in addition to those in the block diagram opposite.

(They can be used ONCE, MORE THAN ONCE or NOT AT ALL).

MOTOR UNIT

OR GATE

THYRISTOR

LIGHT SENSING UNIT

BUZZER UNIT

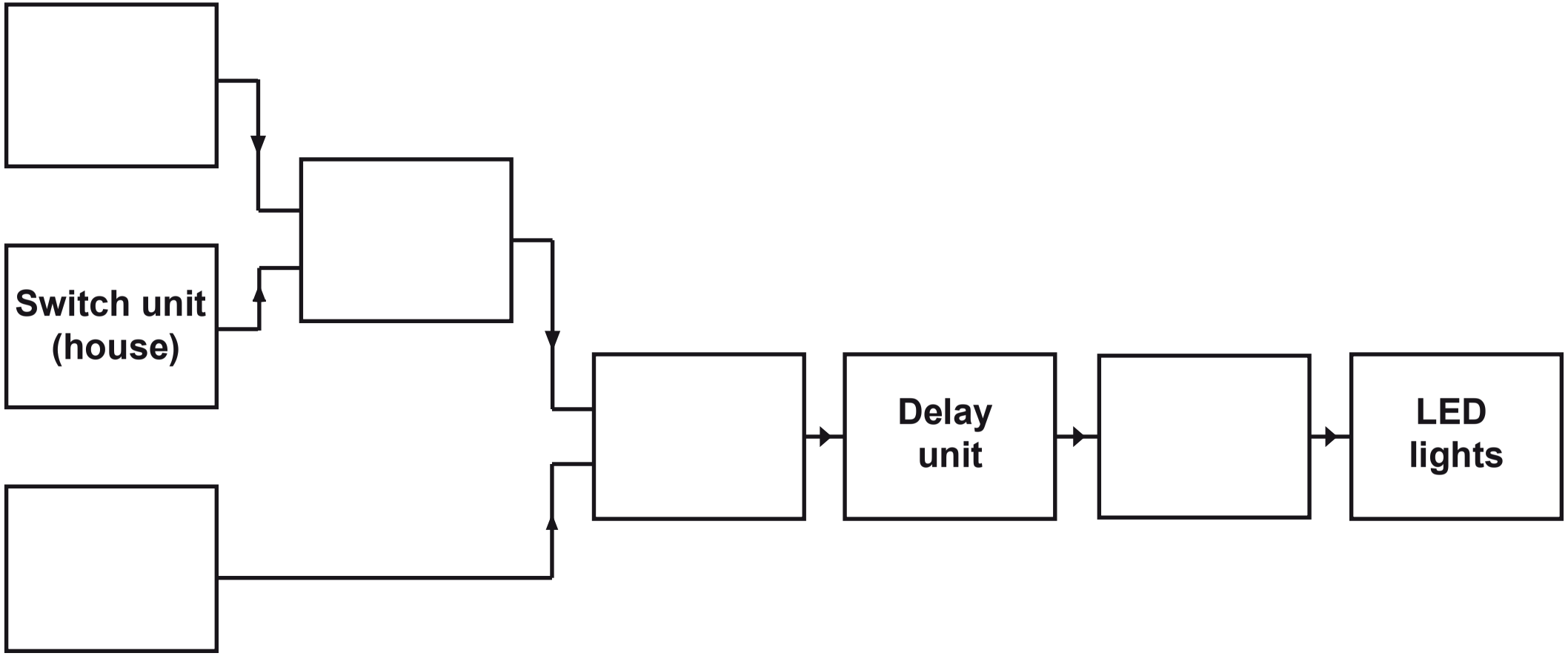
SWITCH UNIT (GATE)

TEMPERATURE SENSING UNIT

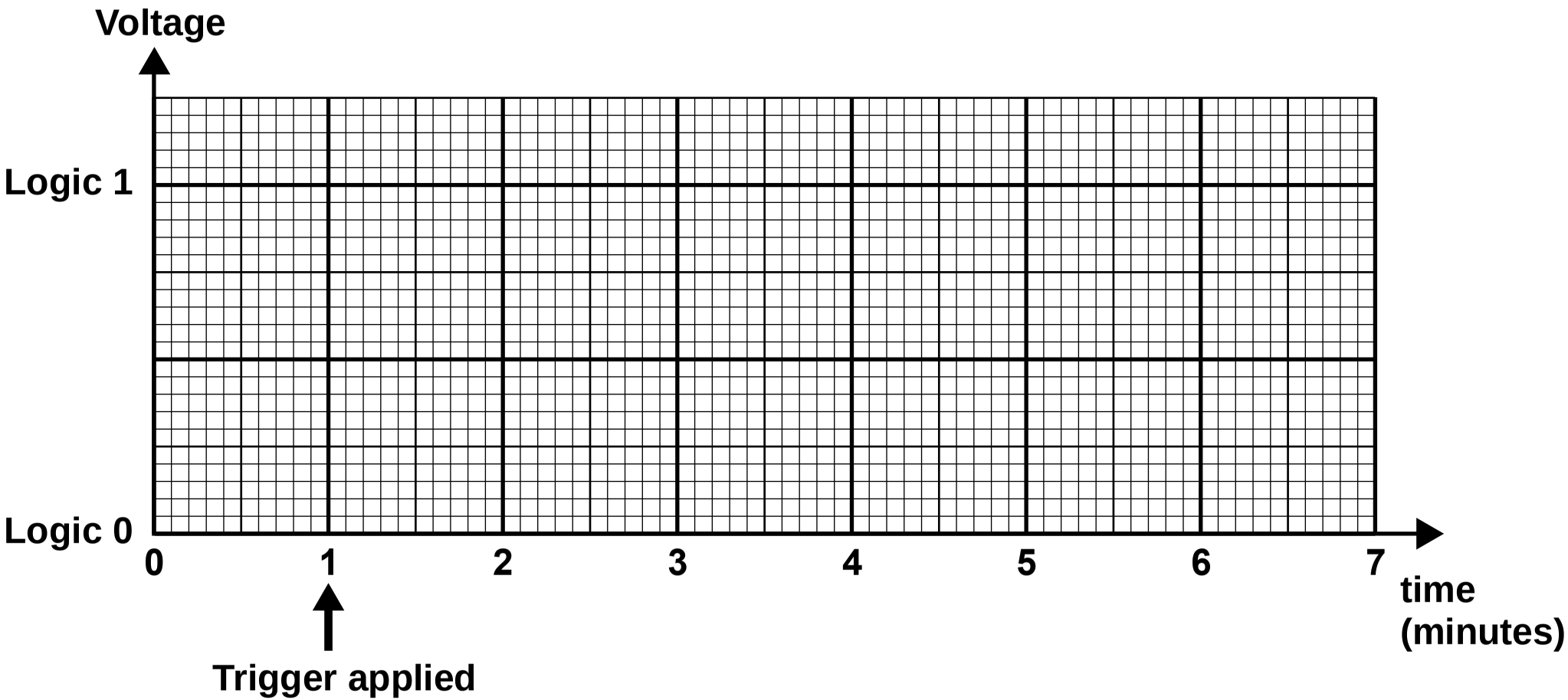
AND GATE

TRANSISTOR DRIVER

Select the correct sub-systems to complete the block diagram design opposite. [5]


Switch unit
(house)
Delay
unit
LED
lights

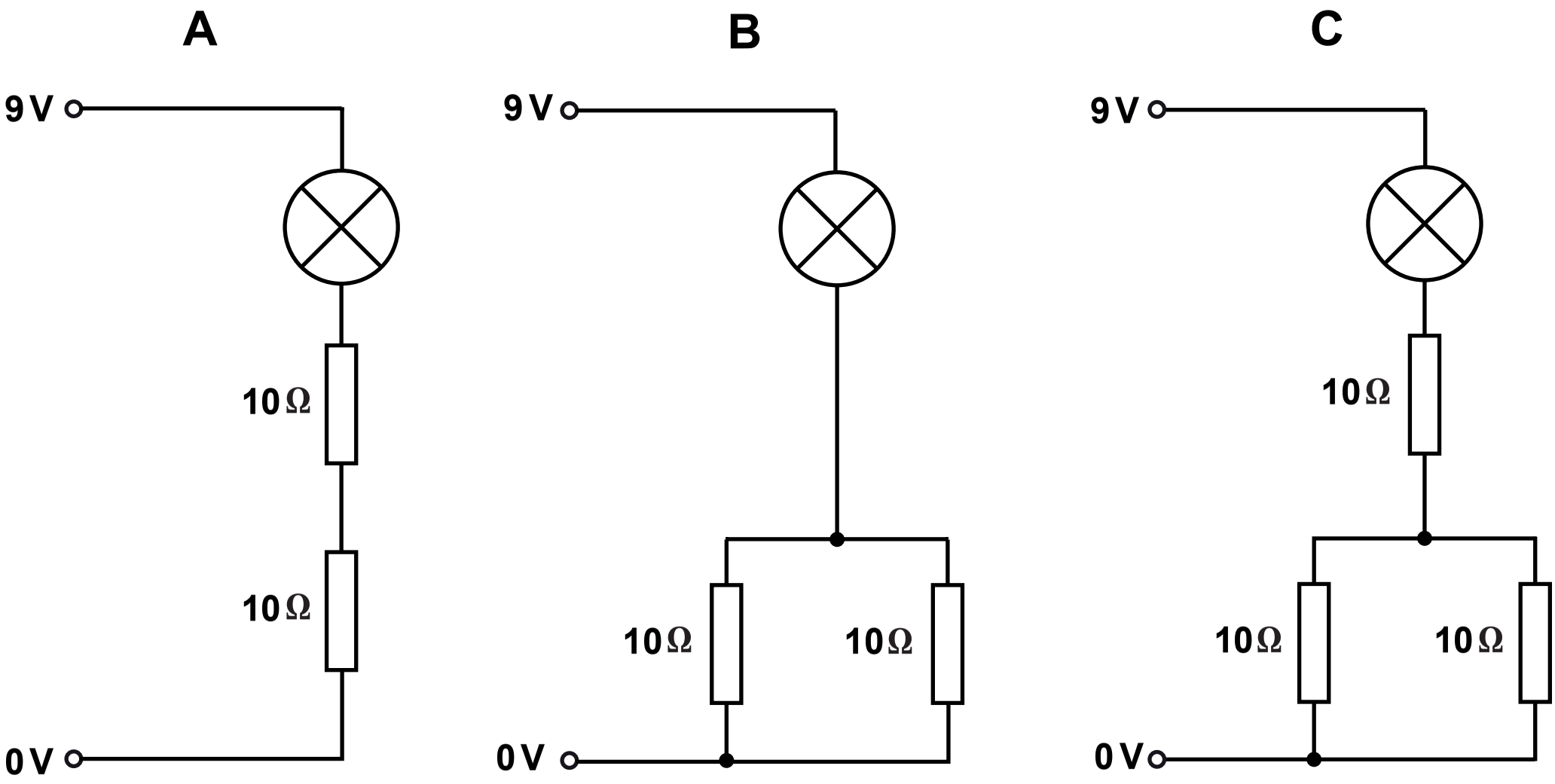
2(c) **Using the axes provided opposite, sketch the output signal required from the delay unit, which is triggered at the time shown. [3]**


Voltage
Logic 1
Logic 0
0
1
2
3
4
5
6
7
time
(minutes)
Trigger applied

3(a) The circuits opposite contain identical batteries and lamps with different combinations of resistors.

In which of the three circuits will the lamp be brightest?

[1]


A
9V
10Ω
10Ω
0V
B
9V
10Ω
10Ω
0V
C
9V
10Ω
10Ω
10Ω
0V

3(b) Draw a labelled network of TWO resistors that will produce a combined resistance of exactly 12 kΩ in the space below. [2]

The following resistor values are available.
Each value can ONLY be selected ONCE.

10 kΩ 18 kΩ 36 kΩ 60 kΩ

3(c) The diagram opposite shows part of a circuit.

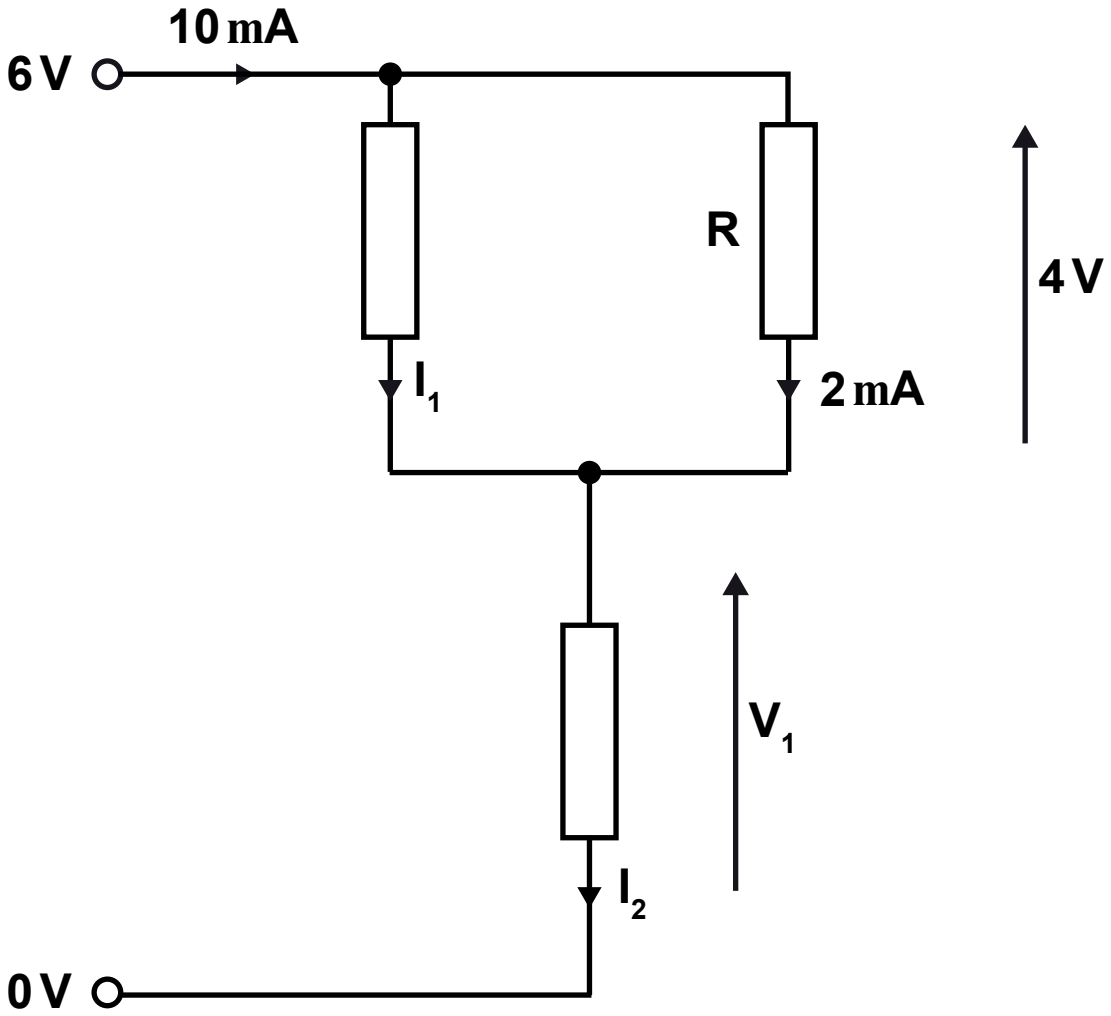
(i) Determine the values of the following: [3]

I_1 = _____

I_2 = _____

V_1 = _____

(ii) Calculate the value of R. [4]


10 mA
6 V
R
4 V
I_1
2 mA
V_1
I_2
0 V

3(d) The colour code on ANOTHER resistor is White, Brown, Red, Gold.

What is the value of the resistor? [3]

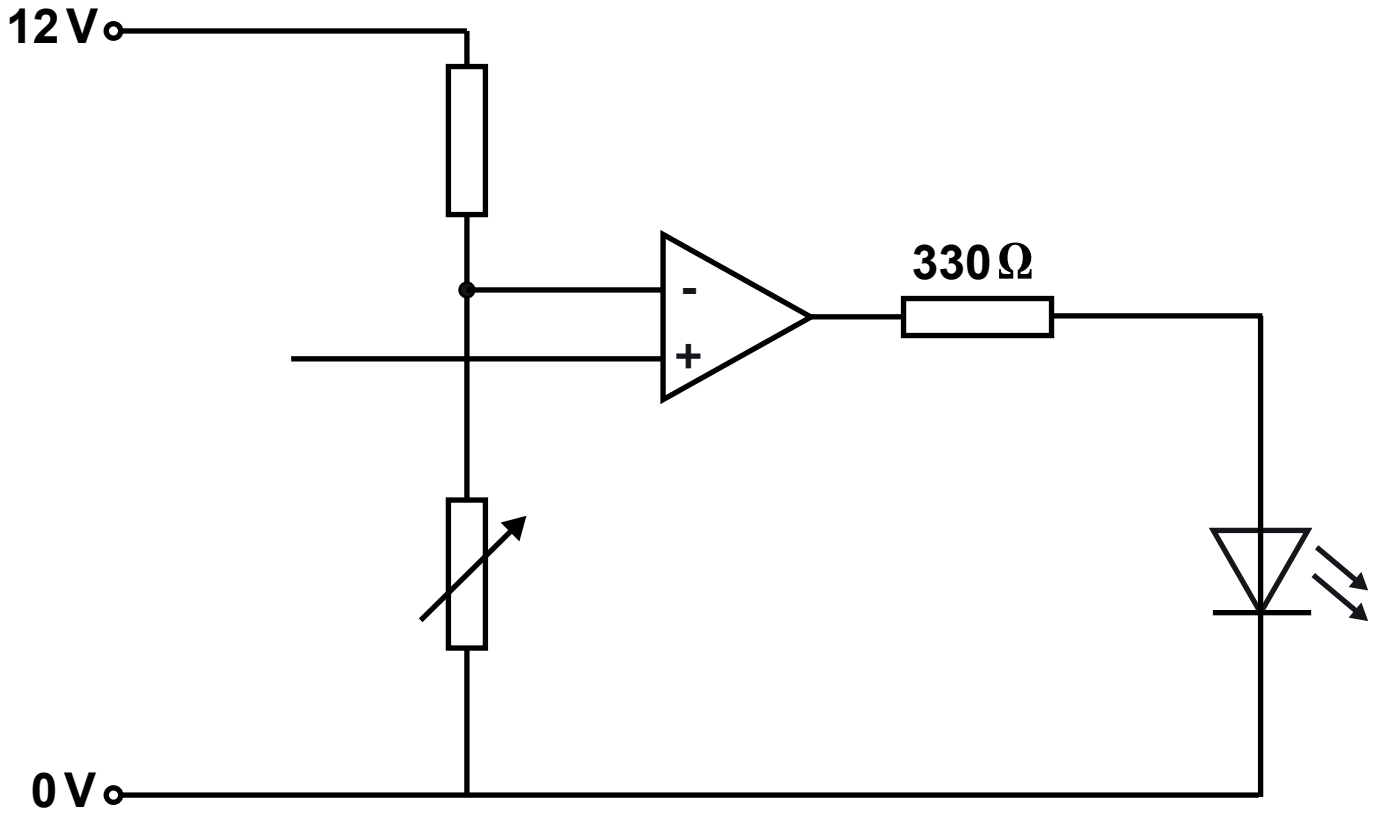
4. **A comparator is used in a system to warn a driver when the temperature outside the vehicle is just above freezing.**

(a) **What is the name of the component that should be used as the sensor in this system? [1]**

(b) **Part of the circuit diagram is shown opposite.**

(i) **The LED should light when the temperature falls below freezing. Complete the diagram by adding the components needed. [2]**

(ii) **Explain the purpose of the variable resistor in the circuit. [1]**


12 V
330 Ω
-
+
0 V

4(c) Determine the power dissipated in the 330 Ω resistor when the LED has a current of 30 mA flowing through it. [3]

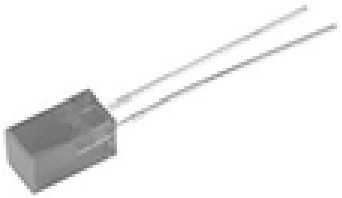
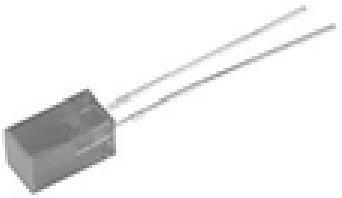
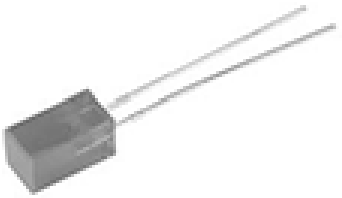
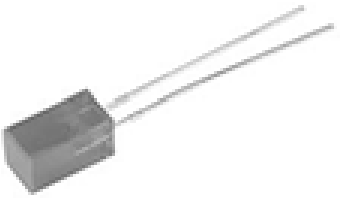
4(d) **The comparator has saturation values of 12 V and 0 V.**

(i) **Calculate the voltage drop across the 330 Ω resistor when the current through it is 30 mA. [2]**

(ii) **What is the resulting voltage drop across the LED? [1]**

4(d) (iii) **The table opposite shows a number of different LEDs that could have been used in this circuit.**

Determine which LED is most LIKELY to have been used in this circuit. [1]

Product	High efficiency Red LED Square 	Yellow LED Square 	Super bright Red LED Square 	Green LED Square 
Dominant Wavelength	625 nm	590 nm	650 nm	565 nm
Forward Current (max)	30 mA	35 mA	35 mA	30 mA
Forward Voltage	2 V	2.1 V	1.85 V	2.2 V
LED colour	Red	Yellow	Red	Green

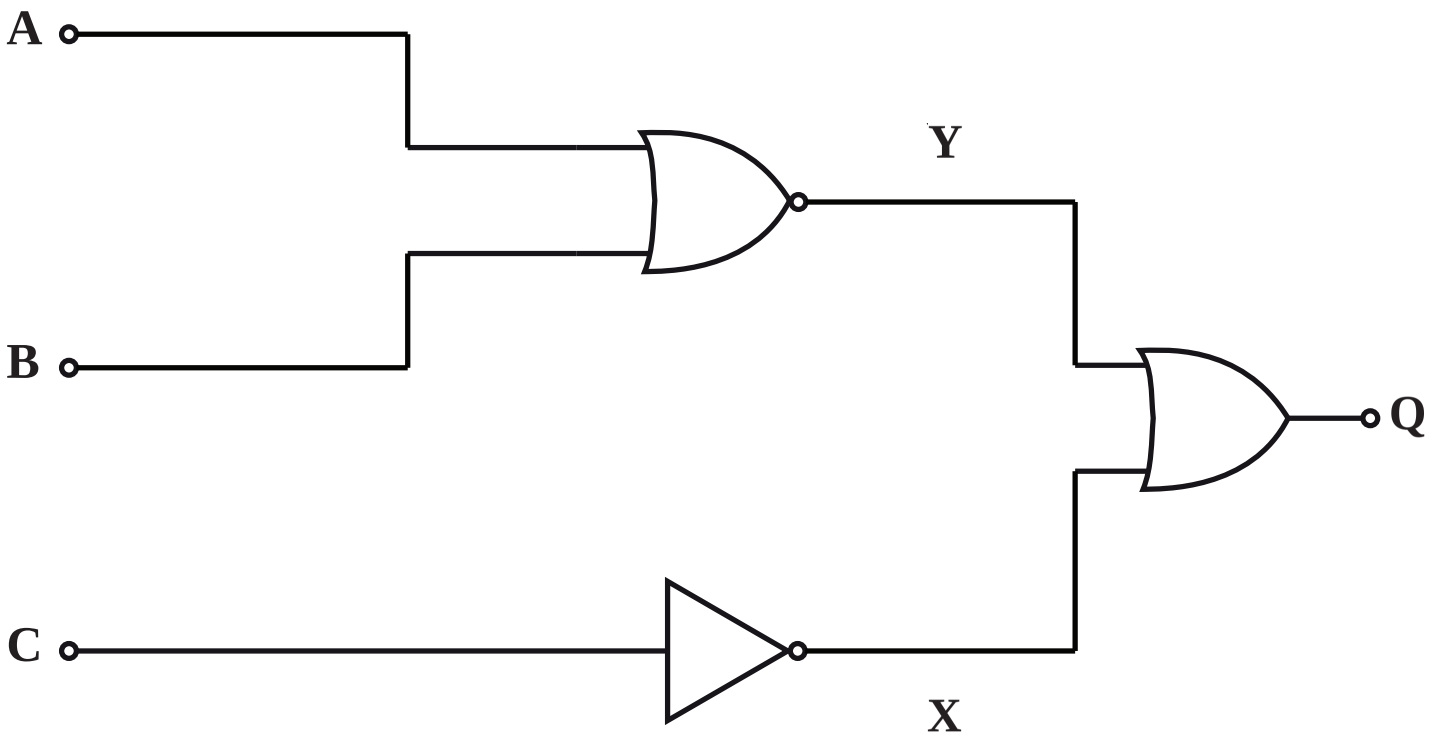
5. The diagram opposite shows a logic system.

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

(i) Output X. _____

(ii) Output Y._____

(iii) Output Q._____


A
B
C
Y
X
Q

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

C	B	A	X	Y	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			

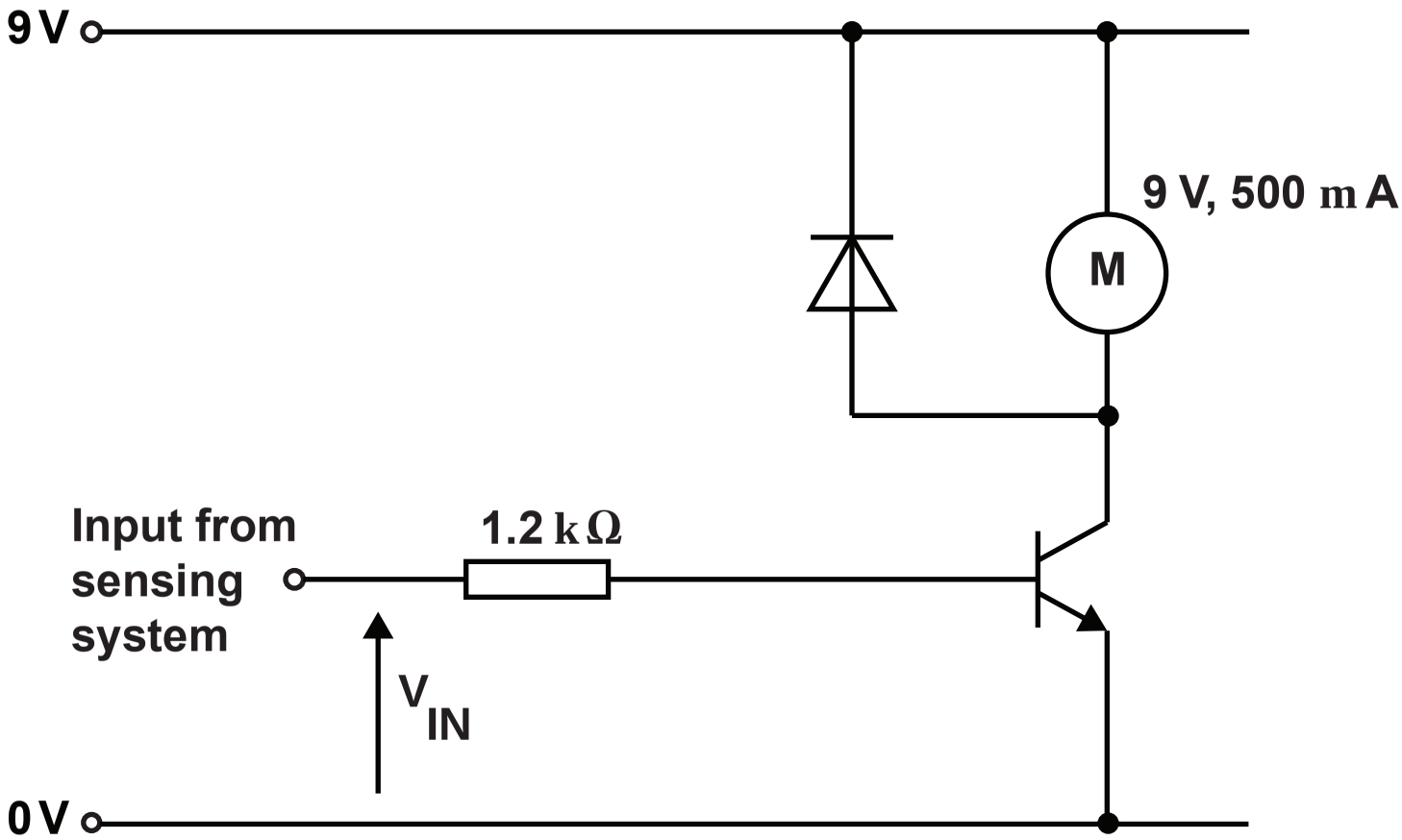
5(c) (i) Redraw the logic circuit using NAND gates only. [3]

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

6. The part of a circuit diagram opposite shows an output driver circuit based on a transistor switch.

(a) The motor operates at 9 V, 500 mA.

Calculate the power dissipated in the motor when operated at these values. [3]


9 V
9 V, 500 mA
M
Input from
sensing
system
1.2 kΩ
V
IN
0 V

6(b) The transistor has a current gain (h_{FE}) of 200. The transistor is just saturated.

Calculate the:

(i) base current I_B. [4]

6(b) (ii) voltage across the 1.2 kΩ resistor. [1]

(iii) value of V_{IN}. [1]

7. **An industrial paint company uses an automated process for mixing different paint colours. The equipment has three paint release valves that open to dispense 1 ml of paint pigment per second. A 1 second delay is required between closing and opening the valve.**

Valve 1: Red pigment

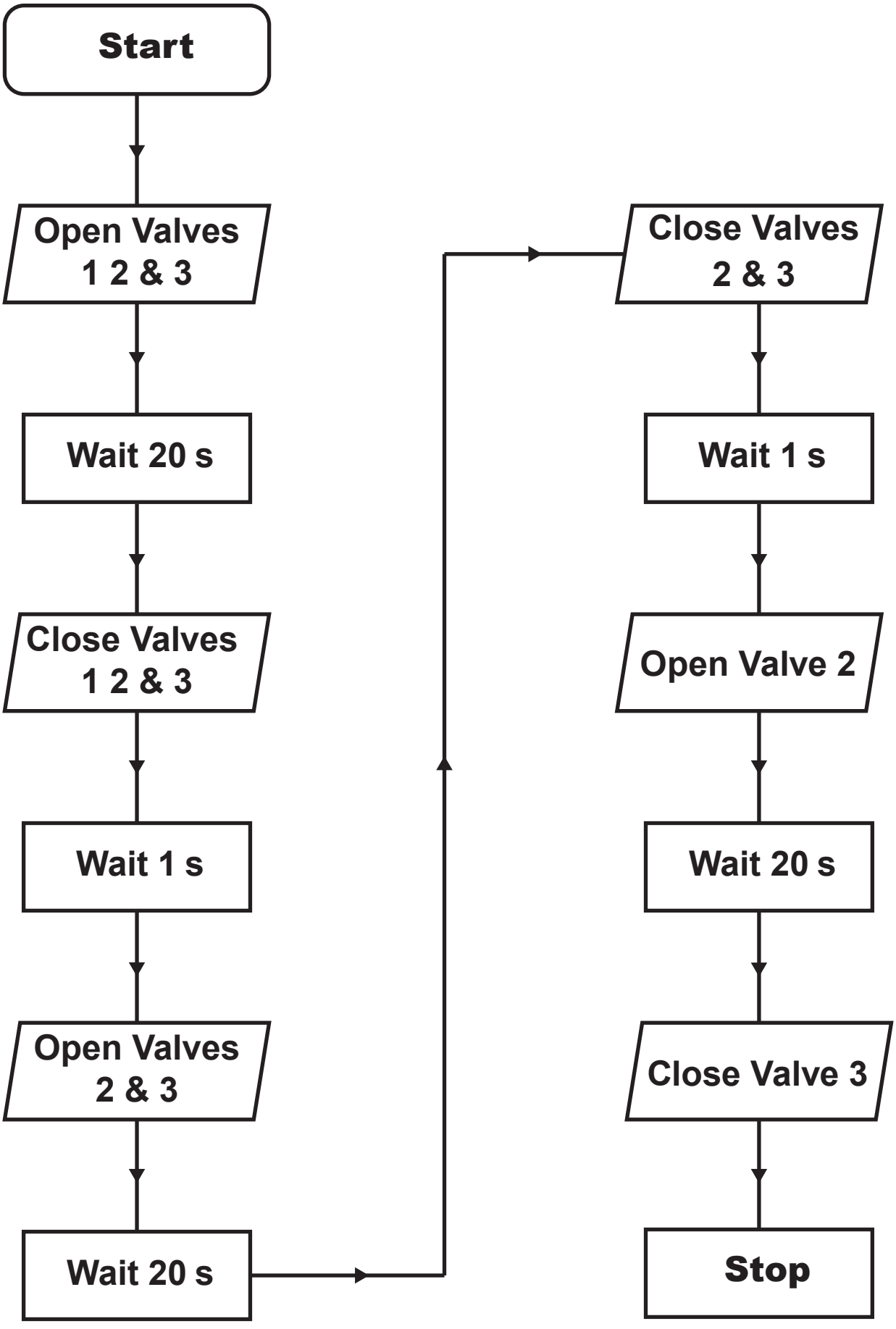
Valve 2: Blue pigment

Valve 3: Yellow pigment

To make a specific colour the required amount of each pigment is as follows:

Red 20 ml, Yellow 40 ml, and Blue 50 ml.

An apprentice has written the program opposite to dispense the coloured pigments.


Start
Open Valves 1 2 & 3
Wait 20 s
Close Valves 1 2 & 3
Wait 1 s
Open Valves 2 & 3
Wait 20 s
Close Valves 2 & 3
Wait 1 s
Open Valve 2
Wait 20 s
Close Valve 3
Stop

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Evaluate the program against the design specification. Clearly explain how the program agrees with or does not agree with the original specification. [6 QER]

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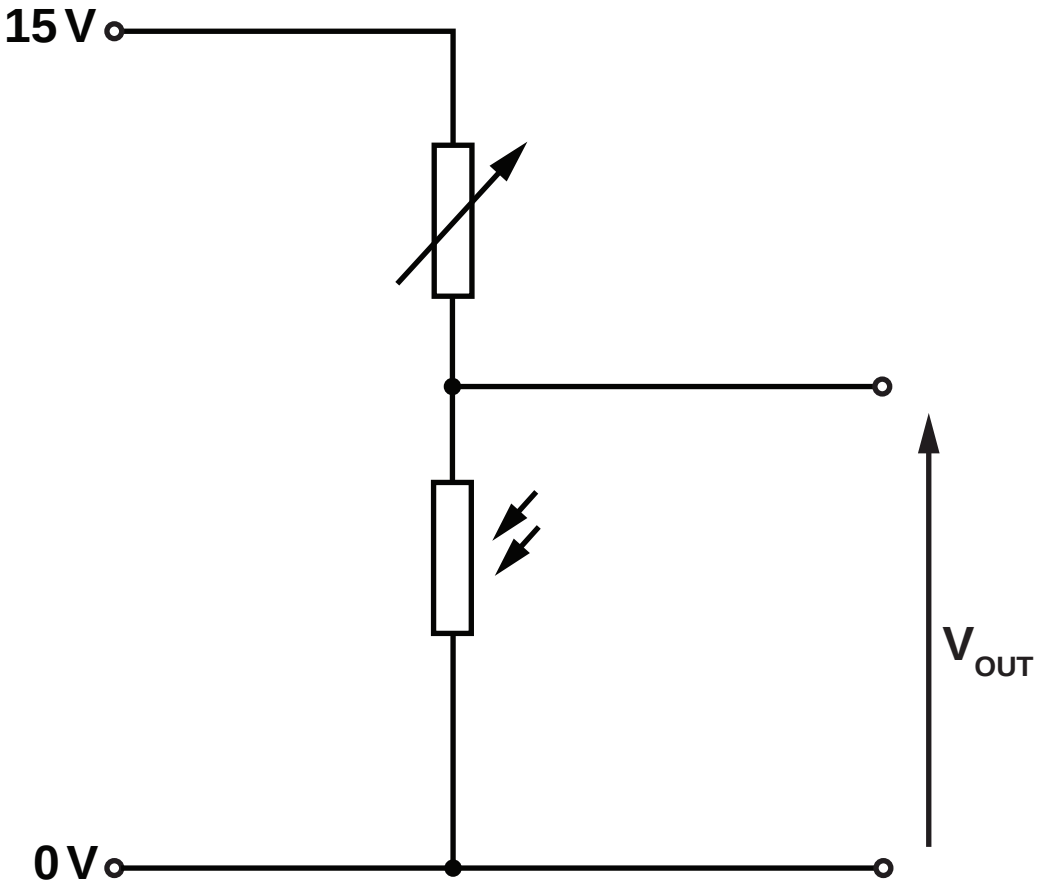
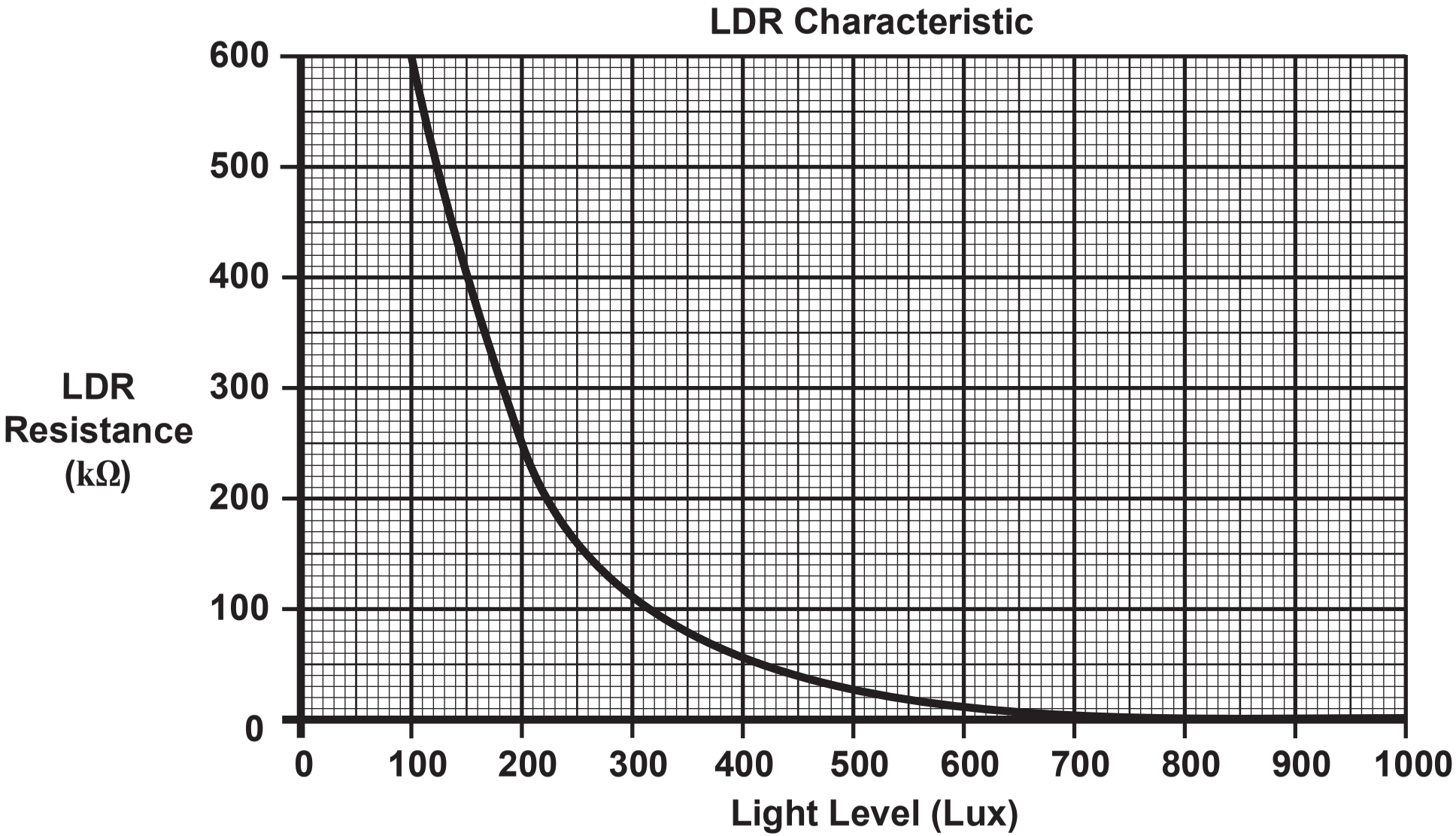
8. Here is the circuit diagram for a light sensing unit, and opposite page 32 the characteristic curve for the LDR.




LDR Characteristic
LDR Resistance (kΩ)
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
Light Level (Lux)

8(a) (i) What is the resistance of the LDR at 200 lux? [1]

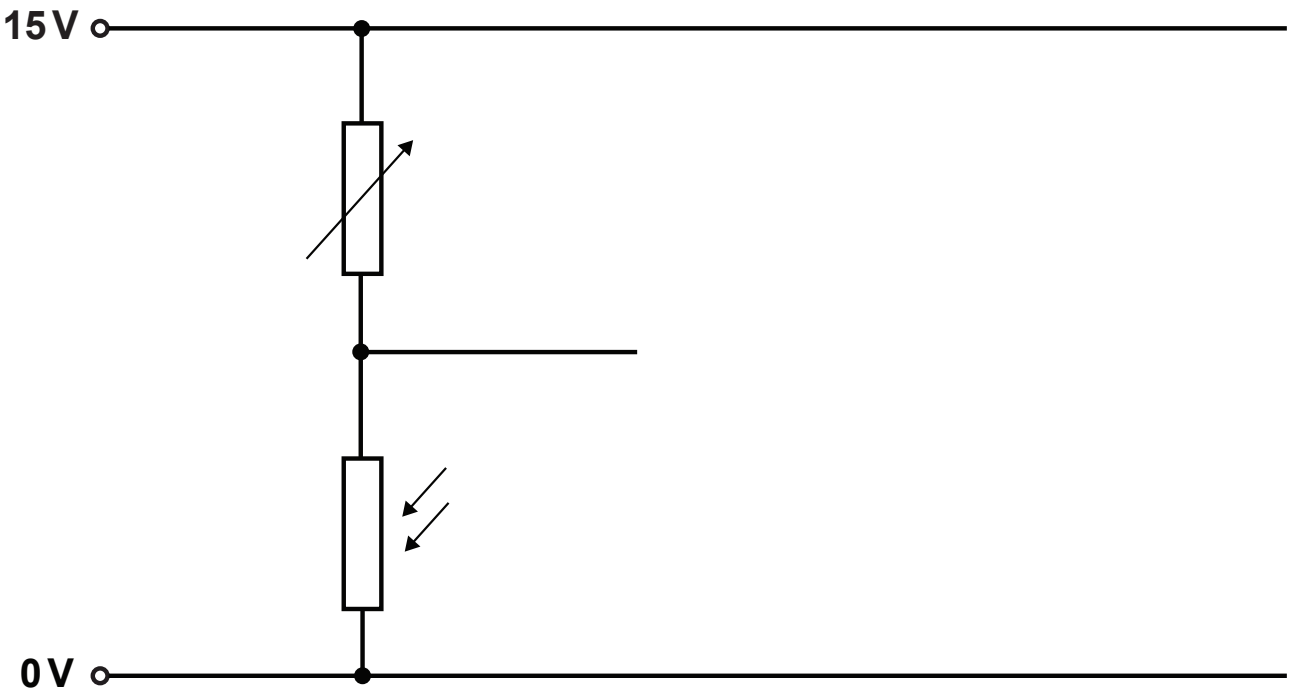
(ii) The variable resistor is set at a resistance of 62.5 kΩ. Calculate V_{OUT} at 200 lux. [3]

8(b) What happens to V_{OUT} when the light level increases? [1]

(c) The light sensor is now connected to a MOSFET. When the light level drops to 200 lux a lamp is switched on. The lamp draws a current of 6 A.

(i) Determine the minimum value of g_M for the MOSFET. [4]

8(c) (ii) Complete the circuit diagram below to show the final design of the lighting system. [2]



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END OF PAPER