

Surname	Centre Number	Candidate Number
Other Names		0



GCSE – NEW

C490UA0-1



WEDNESDAY, 5 JUNE 2019 – MORNING

ELECTRONICS – Component 1
Discovering Electronics

1 hour 30 minutes

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 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 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 \pm 5%

SILVER \pm 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

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

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

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

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

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

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

$$I_C = h_{FE} I_B$$

$$T = 1.1RC$$

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

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

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

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

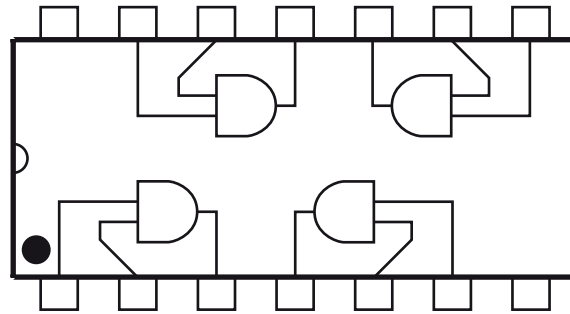
$$G = \frac{V_{OUT}}{V_{IN}}$$

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

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Answer all questions.

1. (a) The diagram 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]

(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]

(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

Complete the table by adding the name of each sub-system in the correct column. [3]

Sensing sub-systems	Signal processing	Output sub-systems
		buzzer unit

(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. (They can be used **once**, **more than once** or **not at all**).

motor unit OR gate thyristor

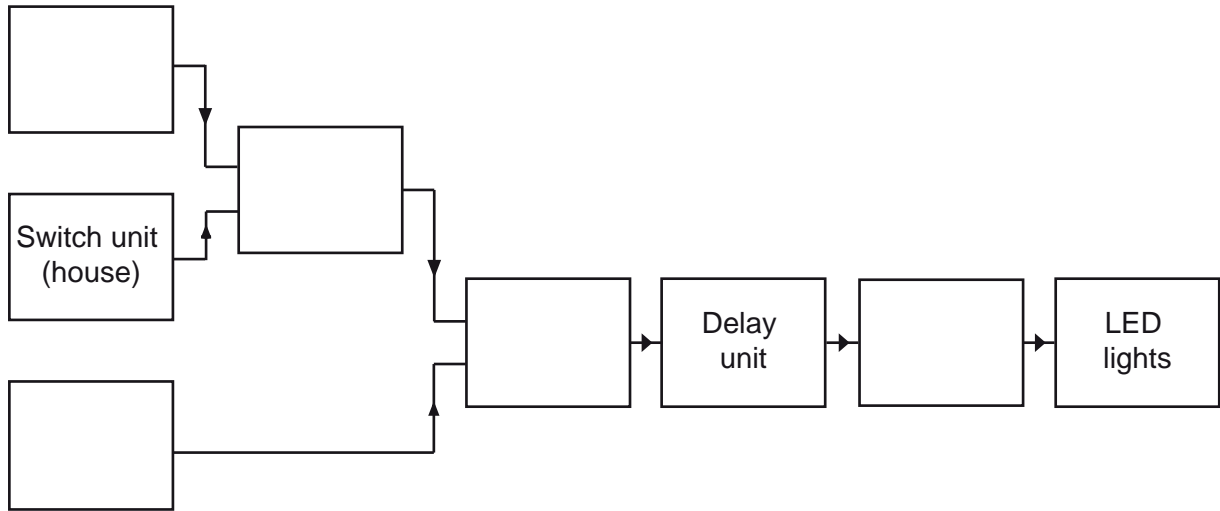
light sensing unit buzzer unit switch unit (gate)

temperature sensing unit AND gate transistor driver

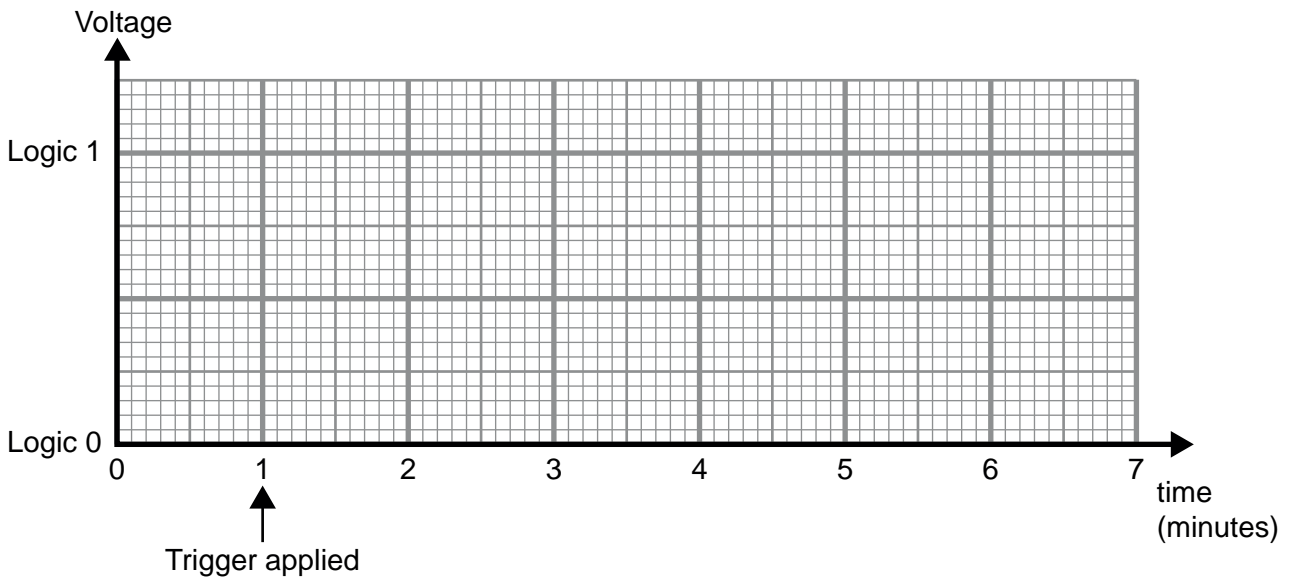
Select the correct sub-systems to complete the block diagram design.

[5]

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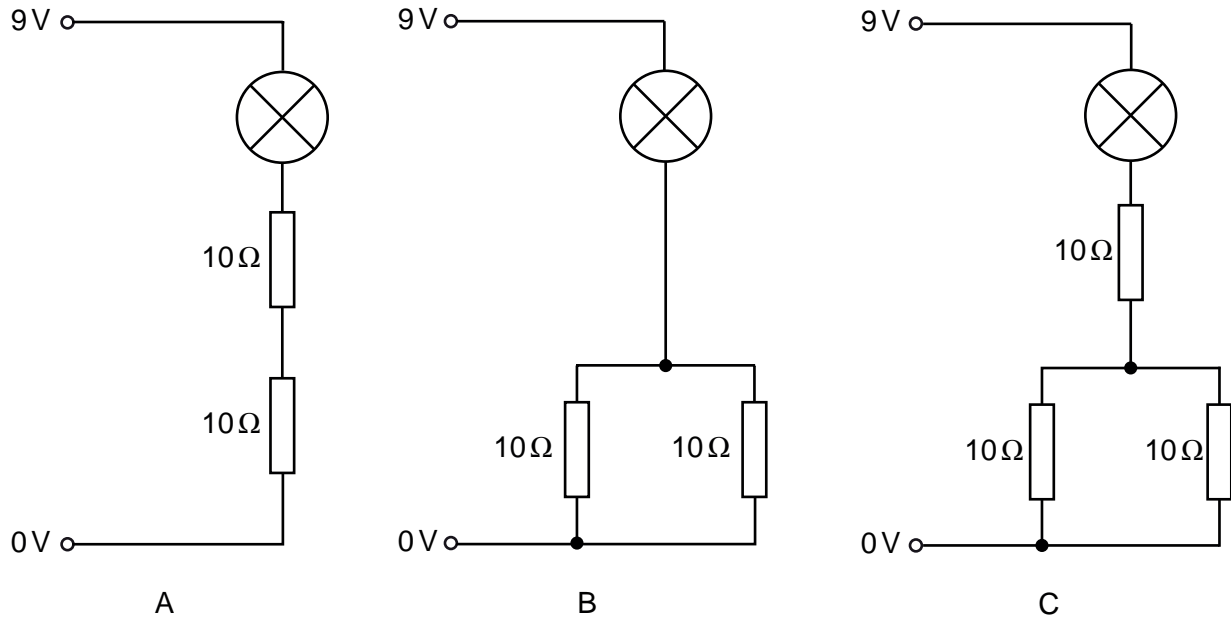


(c) Using the axes provided, sketch the output signal required from the delay unit, which is triggered at the time shown. [3]



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



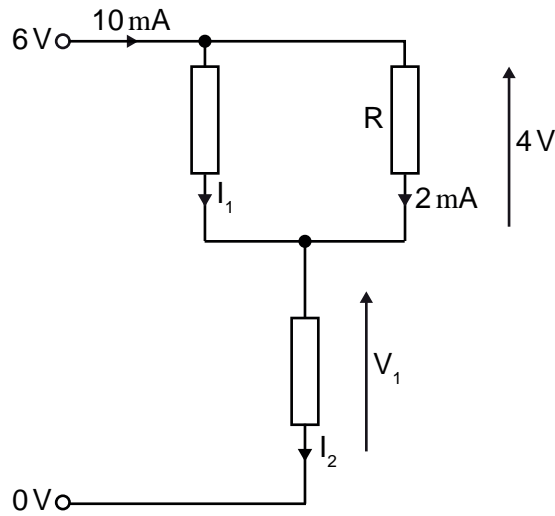
In which of the three circuits will the lamp be brightest? [1]

- (b) Draw a labelled network of **two** resistors that will produce a combined resistance of exactly $12\text{ k}\Omega$ in the space below. [2]

The following resistor values are available. Each value can **only** be selected **once**.

$10\text{ k}\Omega$ $18\text{ k}\Omega$ $36\text{ k}\Omega$ $60\text{ k}\Omega$

(c) The diagram 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]

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(d) The colour code on **another** resistor is White, Brown, Red, Gold.
What is the value of the resistor?

[3]

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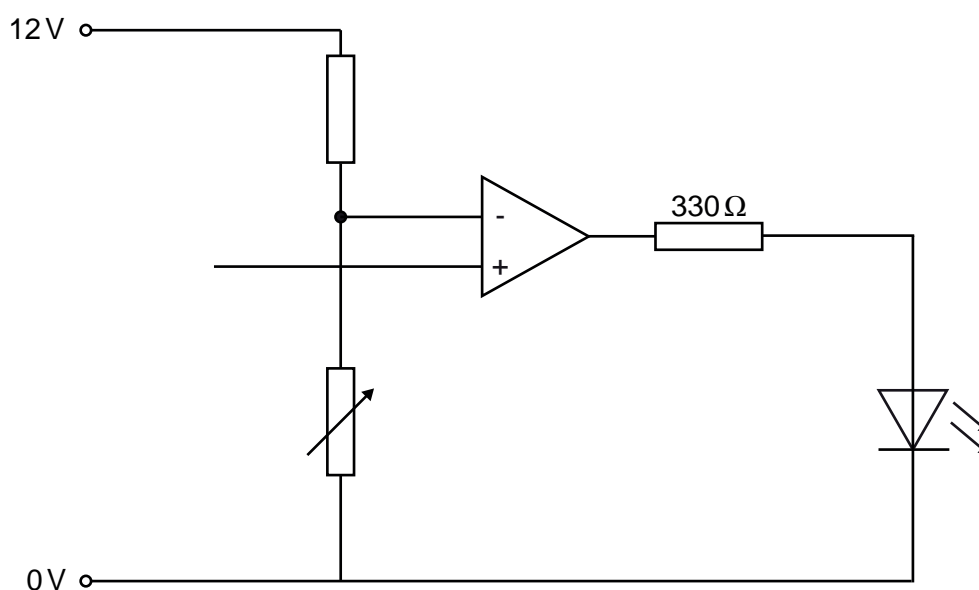
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4. A comparator is used in a system to warn a driver when the temperature outside the vehicle is just above freezing.

(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 below.



(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]

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

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

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





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

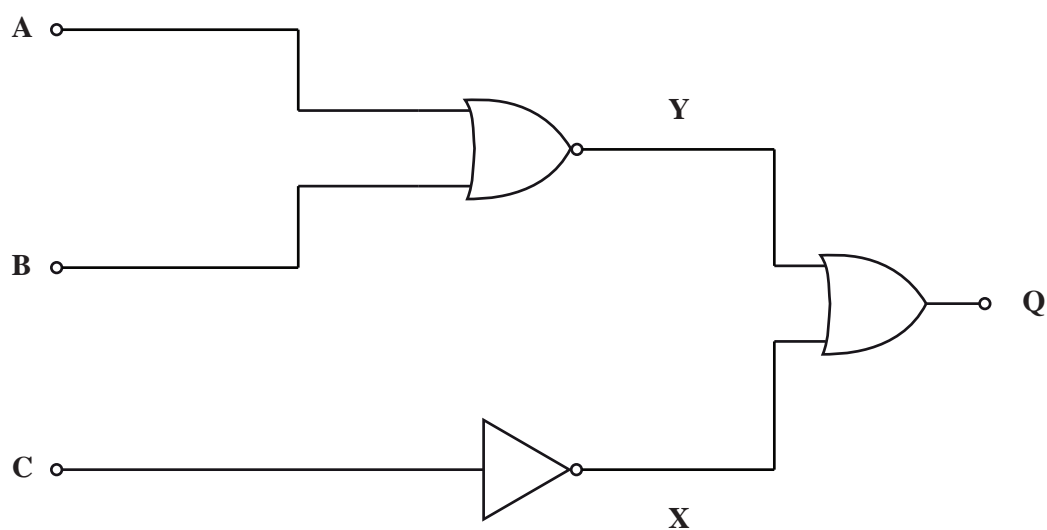
- (iii) The following table shows a number of different LEDs that could have been used in this circuit.

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

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

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5. 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 **X**.

(ii) Output **Y**.

(iii) Output **Q**.

(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			

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

[3]

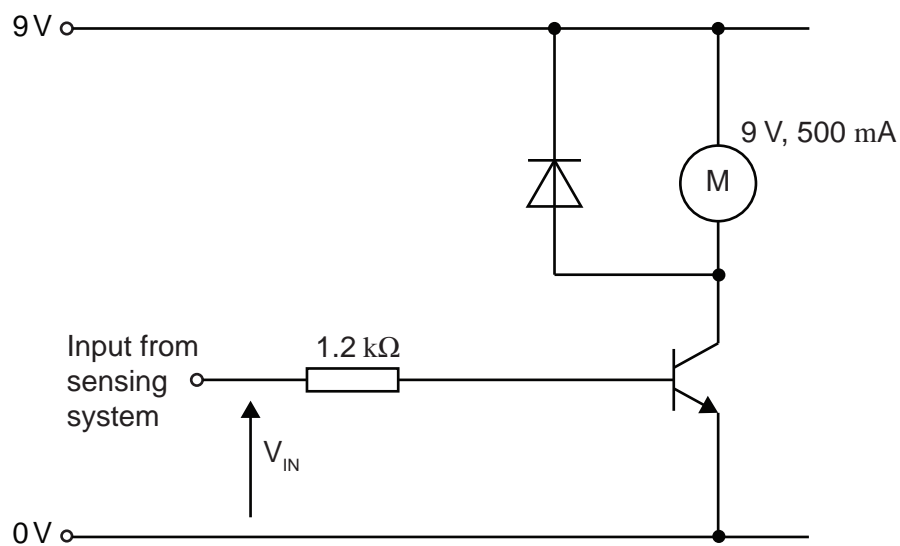
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(ii) Cross out all redundant gates on the diagram above.

[2]

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



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

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

[3]

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

(i) base current I_B .

[4]

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(ii) voltage across the 1.2 k Ω resistor.

[1]

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(iii) value of V_{IN} .

[1]

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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

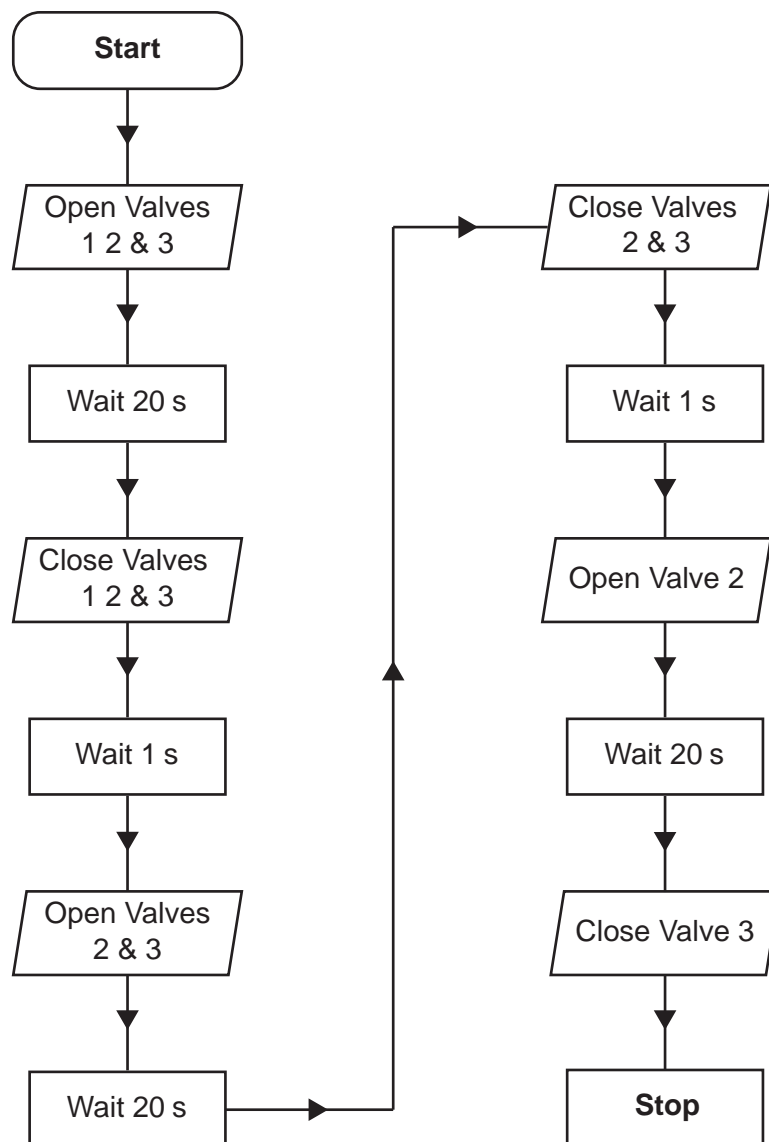
Valve 2: Blue pigment

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 following program to dispense the coloured pigments.



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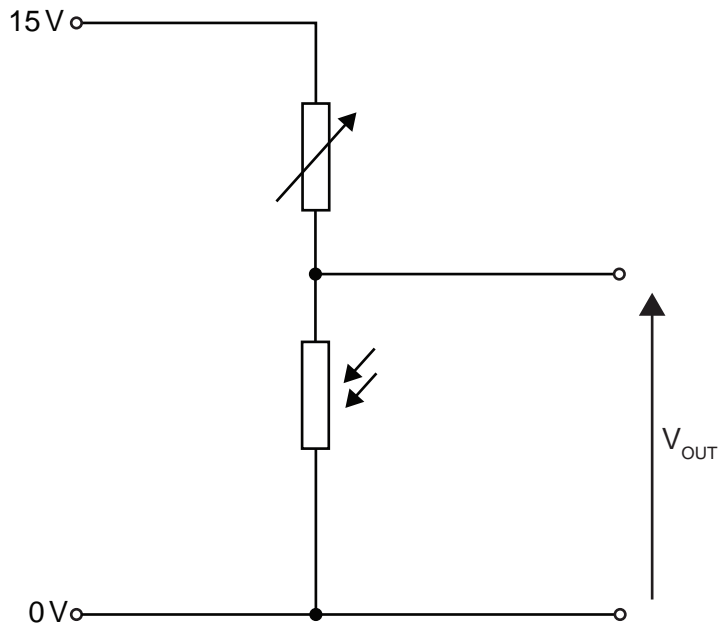
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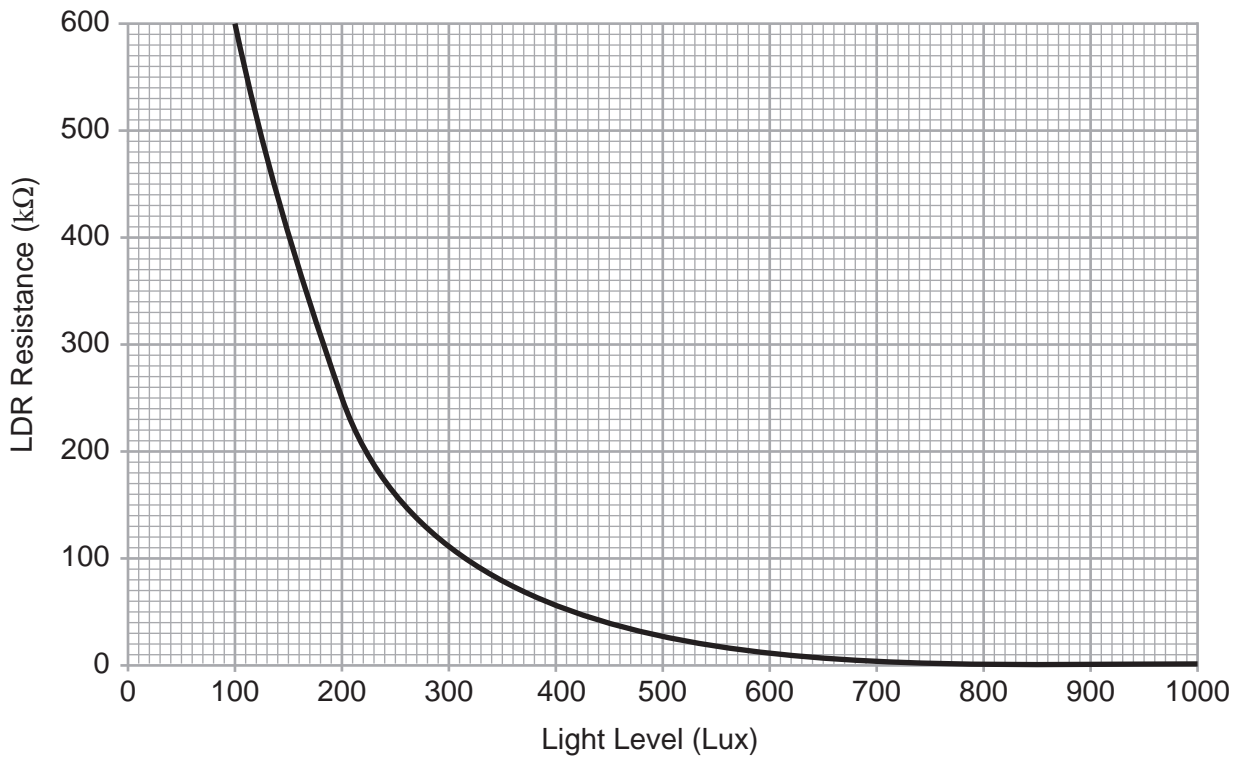
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8. Here is the circuit diagram for a light sensing unit, and the characteristic curve for the LDR.



LDR Characteristic



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

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

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

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(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]

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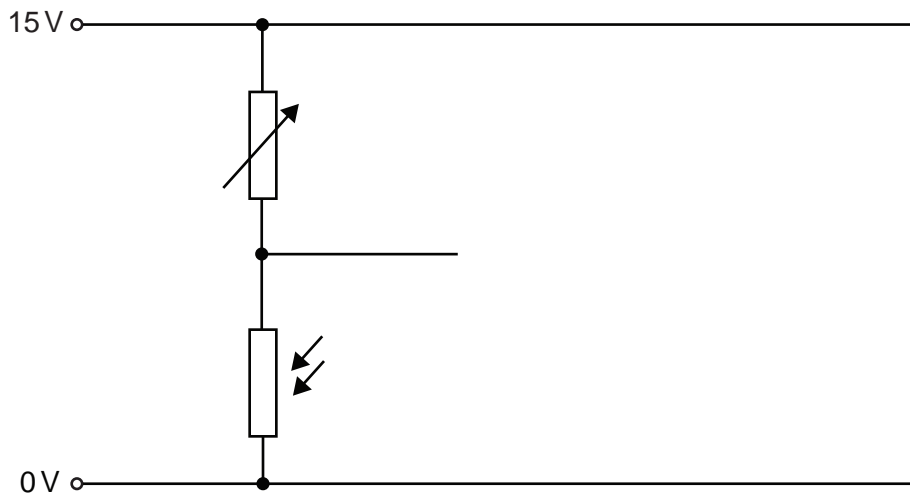
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(ii) Complete the circuit diagram below to show the final design of the lighting system. [2]



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