

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

C490UA0-1



THURSDAY, 8 MAY 2025 – AFTERNOON

ELECTRONICS – Component 1

Discovering Electronics

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	8	
2.	11	
3.	17	
4.	14	
5.	10	
6.	11	
7.	3	
8.	6	
Total	80	

C490UA01
01

ADDITIONAL MATERIALS

You will require 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 8.



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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) Draw the circuit symbol for each of the following logic gates:

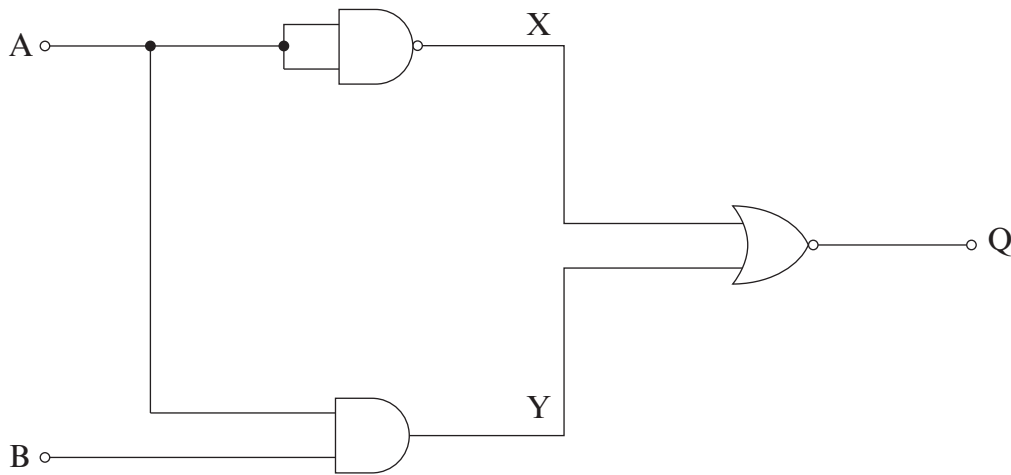
(i) NOT gate

(ii) NOR gate

[2]

(b) Complete the truth table for the following logic system.

[3]



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

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

[1]

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- (d) Which **two** Boolean equations in the list below are correct? Tick (✓) both correct answers. [2]

$$\overline{C+D} = \overline{C} \cdot \overline{D}$$

☐

$$\overline{C+D} = \overline{C} \cdot D$$

☐

$$\overline{C} \cdot \overline{D} = \overline{C+D}$$

☐

$$\overline{C+D} = \overline{C} + \overline{D}$$

☐

$$\overline{C} \cdot \overline{D} = \overline{C} \cdot D$$

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

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

- (i) Which logic gate will provide the X output? [1]

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- (ii) Which logic gate will provide the Y output? [1]

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- (iii) Draw the logic system that will produce the output Q. Use **only** AND, OR and NOT gates in your answer. [4]

A ○ ———

 X

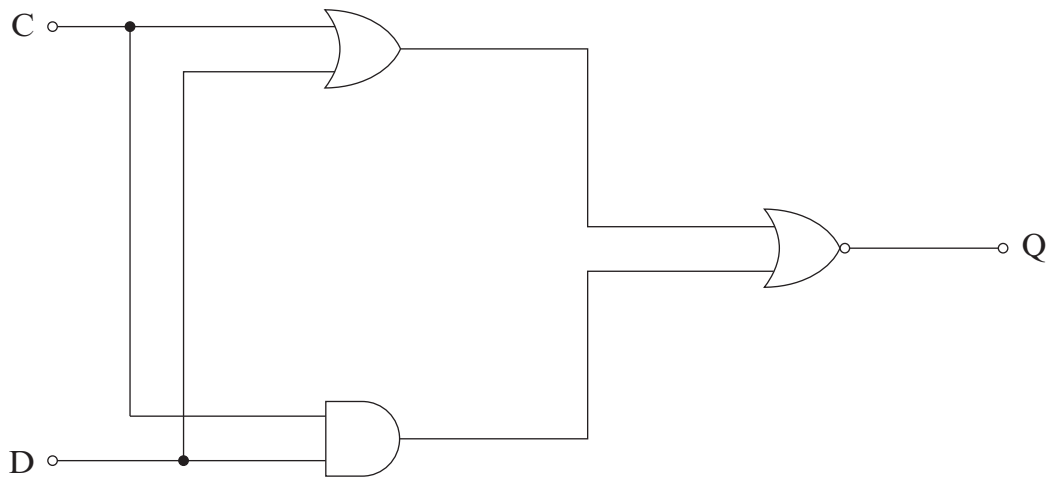
————○ Q

B ○ ———

 Y



(b) A different logic system is shown below.



(i) **Redraw** the circuit using NAND gates only.

[3]

C ○ —

— ○ Q

D ○ —

(ii) **Cross out** all redundant NAND gates.

[1]

(c) Why are logic systems often converted to use only NAND gates?

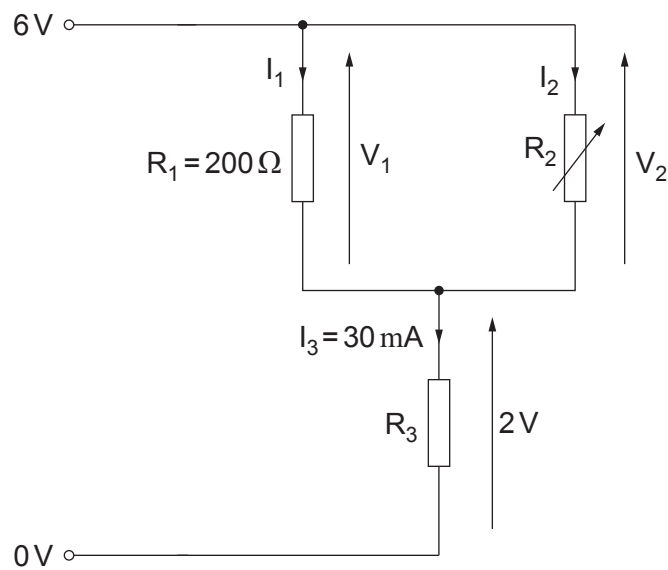
[1]

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3. The circuit diagram below shows a network of resistors connected to a 6 V power supply.



(a) 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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(b) State the value of V_2 .

[1]

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(c) Calculate the resistance setting of the variable resistor R_2 .

[4]

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(d) What is the colour code on resistor R_1 which has a tolerance of $\pm 5\%$?

[4]

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4. (a) Complete the table by writing the sub-systems given below in the correct column. [3]

Latch unit

NOR gate

Comparator

Light sensing unit

Solenoid unit

Moisture sensing unit

Delay unit

Buzzer unit

MOSFET

Input sub-system	Processing sub-system	Output sub-system



- (b) A local council is in the process of upgrading a school's external lights to LED lights because they are cheaper to run and last longer.

The LED lights need to switch on automatically when it gets dark and switch off when it gets light again.

A press-switch is included to allow the caretaker to check that the LED lights are working properly.

The following sub-systems are available:

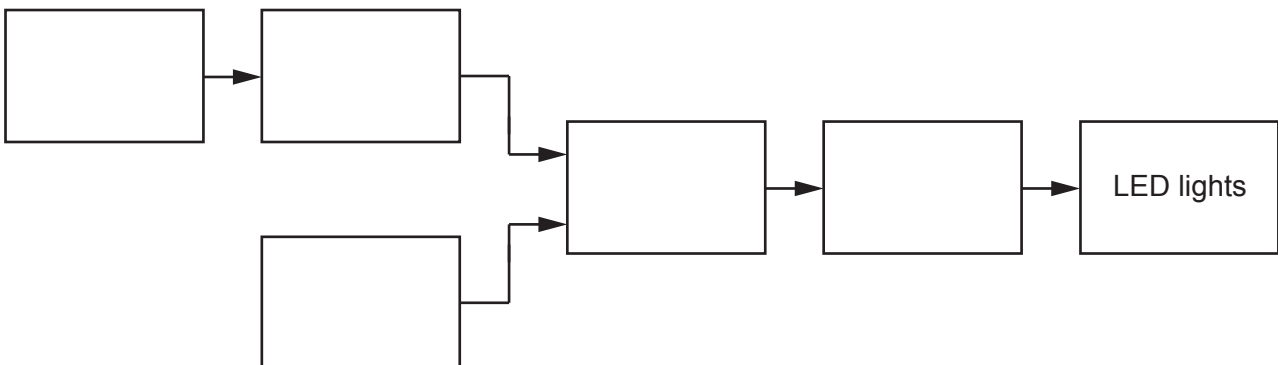
Pulse generator	NOT gate	Temperature sensing unit	AND gate
NAND gate	Comparator	Pressure switch unit	OR gate
Transistor switch	Latch unit	Light sensing unit	Switch unit

The available sensing sub-systems behave as follows:

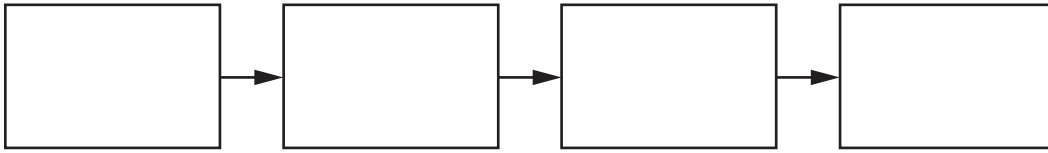
- The light sensing unit outputs logic 0 in the dark.
- The pressure switch unit outputs logic 0 when closed.
- The temperature sensing unit outputs logic 1 when hot.
- The switch unit outputs a logic 1 when pressed.

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

[5]



- (c) The block diagram for a public address (PA) system used in the school hall is shown below.



- (i) Write the names of the four blocks in the boxes on the above diagram. Choose from the following list: [3]

Power Amplifier

Loudspeaker

Preamplifier

Comparator

Microphone

- (ii) A pupil wants to add a guitar input to the PA system to play a guitar whilst singing during assembly.

Redraw the PA system to show how the guitar input can be added. Additional blocks will be needed. [3]

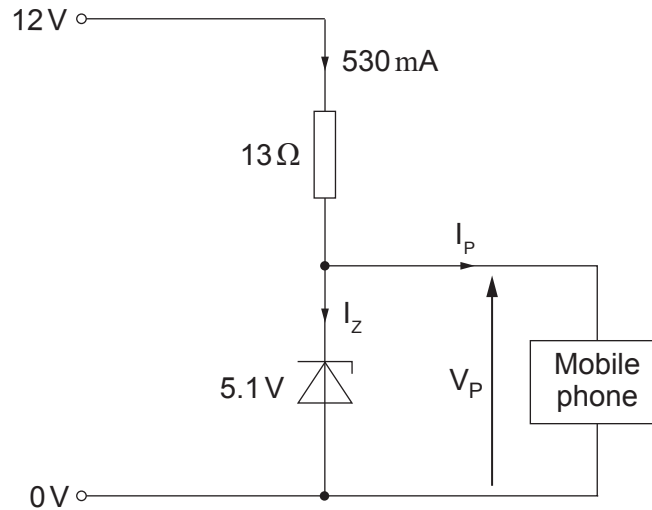


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5. The diagram below shows the design for a mobile phone charger which runs from a 12 V car battery. The mobile phone requires a maximum charging current I_P of 500 mA. A 5.1 V zener diode with a holding current I_Z of 12 mA is used.



- (a) Calculate the zener current, I_Z , when the mobile phone takes its maximum charging current. [2]

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- (b) Calculate the voltage across the 13Ω resistor. [2]

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- (c) Resistors are available with maximum power ratings of 1 W, 2 W, 5 W or 10 W.

Calculate the power dissipated in the resistor and select the most appropriate power rating for it. [4]

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(d) During a long car journey the car battery charges up to 13.4 V.

(i) What is the value of V_P now?

[1]

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(ii) What is the voltage across the 13Ω resistor now?

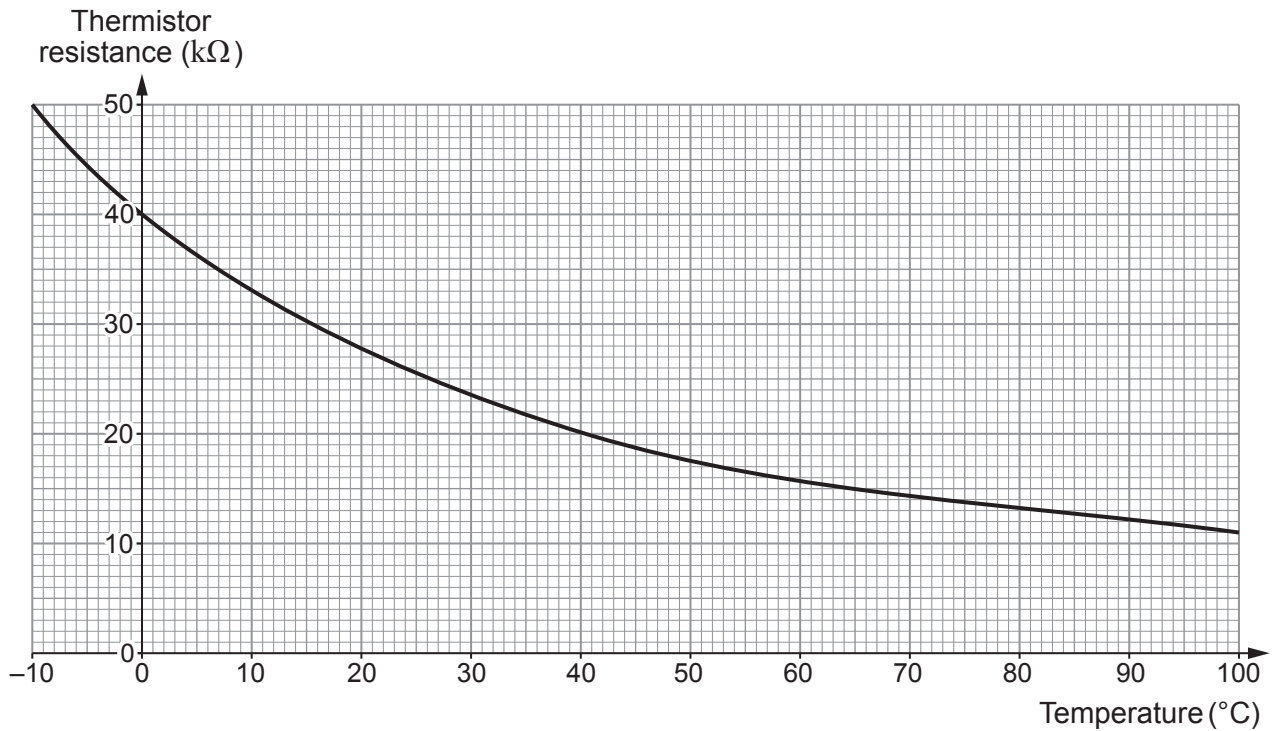
[1]

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10



6. A student designs a system to switch on a small air conditioning unit when the temperature in a room exceeds 24°C .
The characteristic of the thermistor to be used in the design is shown below.

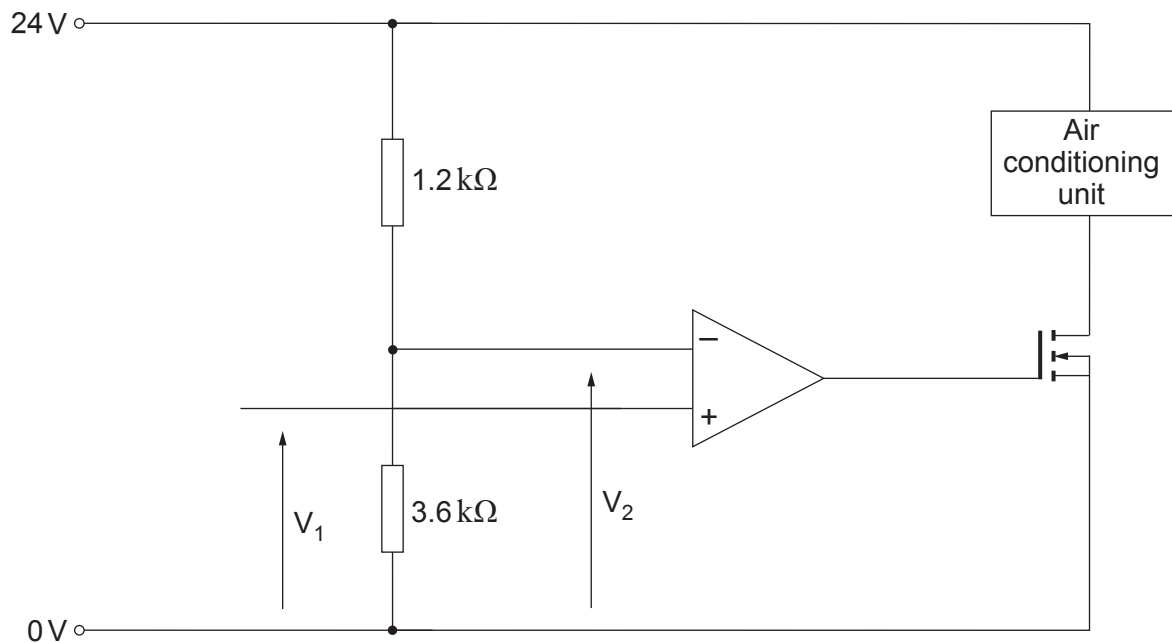


- (a) Use the thermistor characteristic to determine the resistance of the thermistor at 24°C . [1]

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Part of the student's design is shown below. The op-amp saturates at 0V and 22V.



- (b) **Complete the design** by adding a thermistor and a resistor so that the air conditioning unit will turn on when the temperature rises above 24 °C. [3]
- (c) Calculate the value of V_2 . [3]

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- (d) The maximum current taken by the air conditioning unit is 12 A. The MOSFET just saturates when the gate voltage is 22 V. Calculate the value of g_M for the MOSFET. [4]

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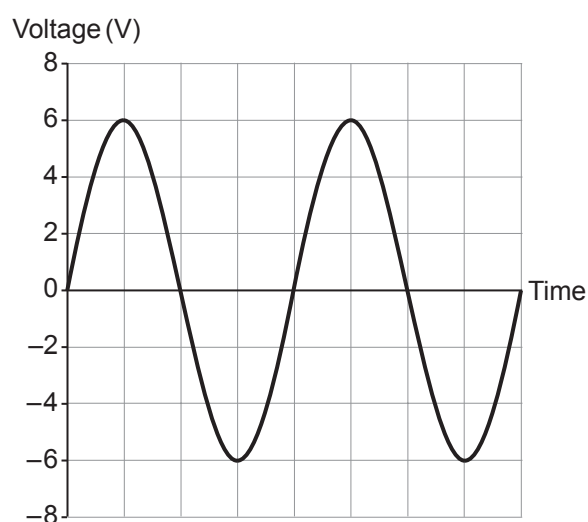
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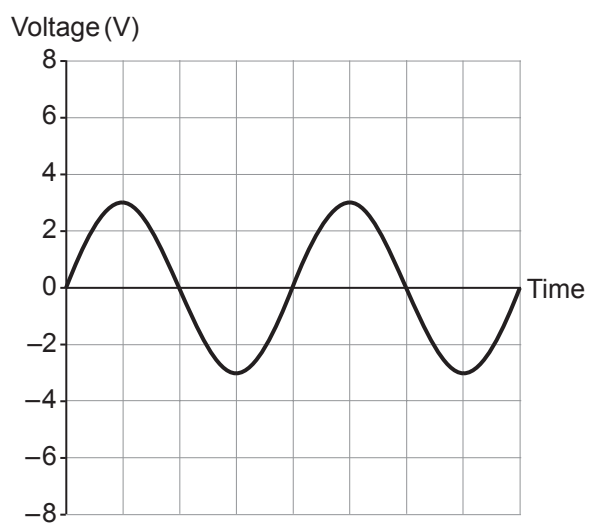
7. (a) Complete the circuit diagram below to make a half-wave rectifier. [1]



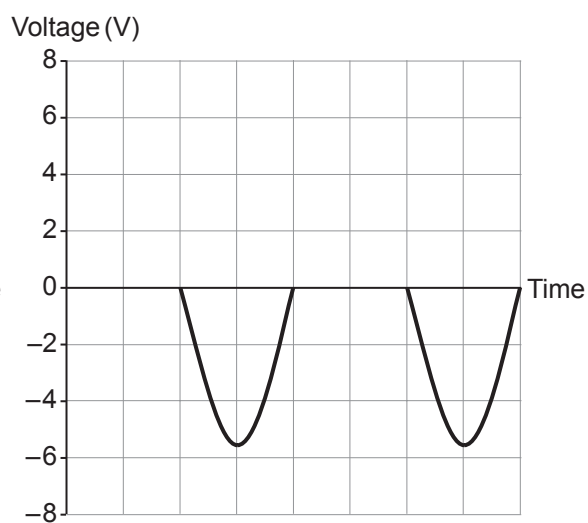
- (b) The output of the transformer is shown below:



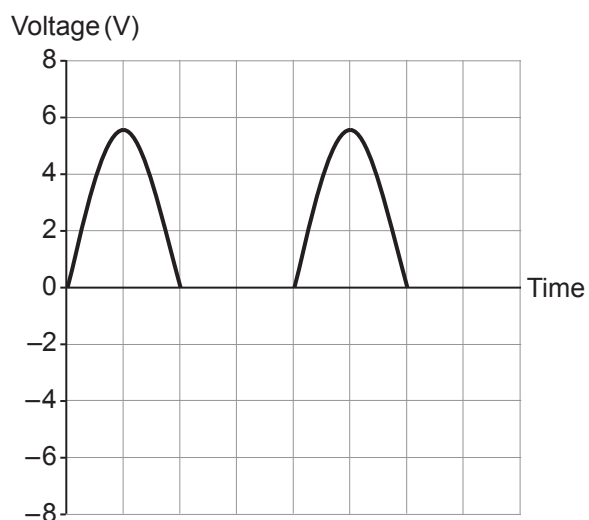
Which **two** of the following oscilloscope screens show **possible outputs** of a half-wave rectifier. Tick (✓) the boxes **A**, **B**, **C** or **D**. [2]



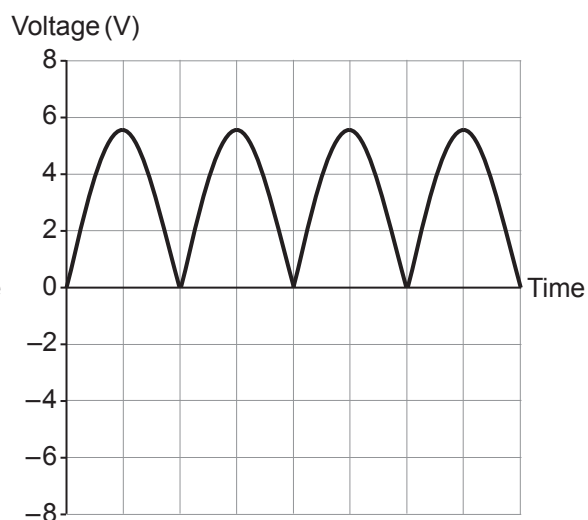
A ☐



B ☐



C ☐



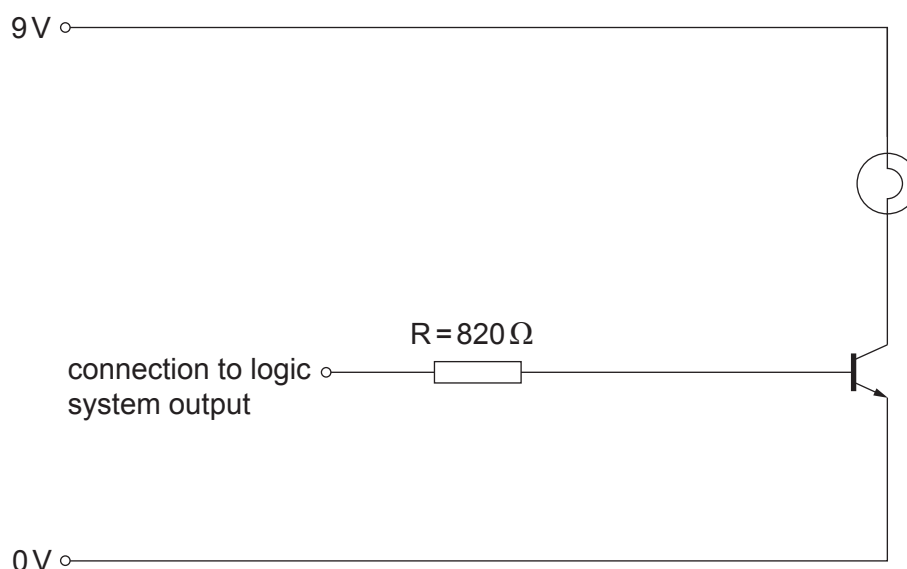
D ☐



8. The design for a driver circuit, to interface a logic system to a lamp, is shown below.

Driver circuit specification:

- The system must run from a 9V power supply.
- The lamp should be fully lit when the logic system outputs logic 1.



The parameters for the driver circuit are as follows:

- For the logic system output, logic 0 is 0V and logic 1 is 7V.
- The lamp has maximum ratings 18W, 9V
- The transistor has current gain $h_{FE} = 200$
- When the logic system output is at logic 1, the transistor is **just saturated**.

Evaluate the driver circuit against the specification, including appropriate calculations. Suggest any modifications required to meet the specification. [6 QER]

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6



[illegible]