

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

C490UA0-1



TUESDAY, 16 NOVEMBER 2021 – AFTERNOON

ELECTRONICS – Component 1
Discovering Electronics

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	6	
2.	9	
3.	13	
4.	4	
5.	14	
6.	6	
7.	9	
8.	13	
9.	6	
Total	80	

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 **9**.



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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

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

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

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

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

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

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

$$I_C = h_{FE} I_B$$

$$T = 1.1RC$$

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

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

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

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

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

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



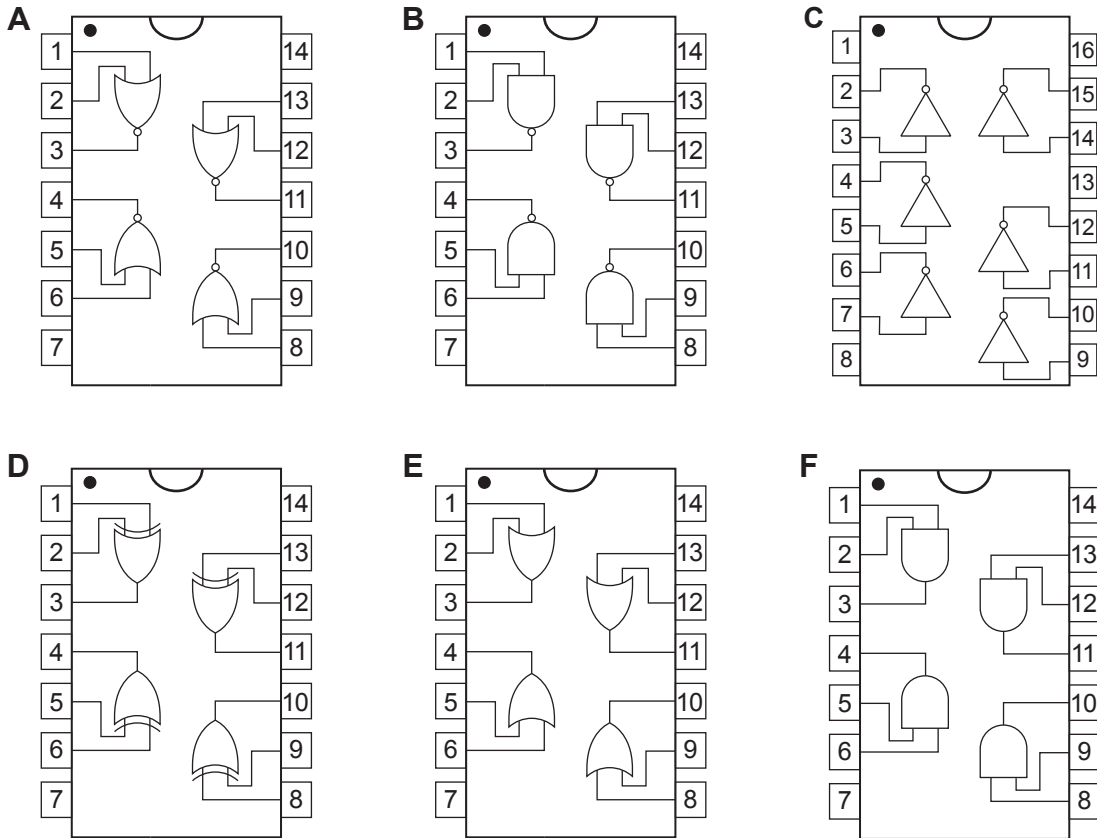
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Answer all questions.

1. The diagram shows the pinout diagrams for a number of logic ICs (integrated circuits).



(a) Which IC (A to F) contains:

(i) AND gates

(ii) NOT gates

[2]

(b) (i) Which logic IC (A to F) contains logic gates with the following truth table? [1]

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

Answer



(ii) Which logic IC (**A** to **F**) contains logic gates with the following truth table? [1]

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

Answer

(c) Complete the following truth tables for:

(i) a logic gate in package **F**. [1]

B	A	Q
0	0	
0	1	
1	0	
1	1	

(ii) a logic gate in package **A**. [1]

B	A	Q
0	0	
0	1	
1	0	
1	1	



2. (a) A number of electronic sub-systems are listed below.

- OR gate**
- Transistor switch unit**
- Buzzer unit**
- Temperature sensing unit**
- Delay unit**
- Switch unit**
- Light sensing unit**
- Solenoid unit**
- Comparator unit**

Write each sub-system into the correct column in the table below.

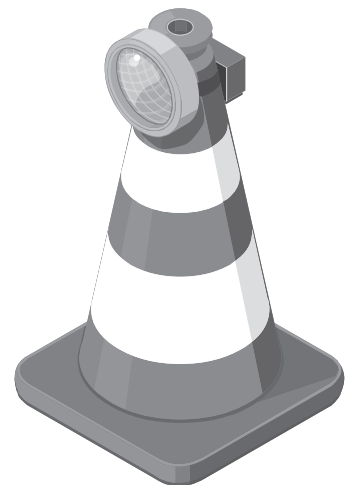
[3]

Input sub-systems	Processing sub-systems	Output sub-systems

(b) The highways agency uses battery-operated flashing lights on traffic cones to warn drivers of roadworks.

SPECIFICATION

- The light should flash on and off to alert drivers of roadworks.
- To preserve battery life, the light should flash only when it gets dark and stop when it gets light.
- There should be a test switch that allows workers to test the light during the daytime.



The following sub-systems are available.

- OR gate**
- Temperature sensing unit**
- Light sensing unit**
- Lamp unit**
- Moisture sensing unit**
- Latch unit**
- Pulse generator**
- Switch unit**
- AND gate**
- Transistor switch unit**
- Comparator unit**
- NOT gate**

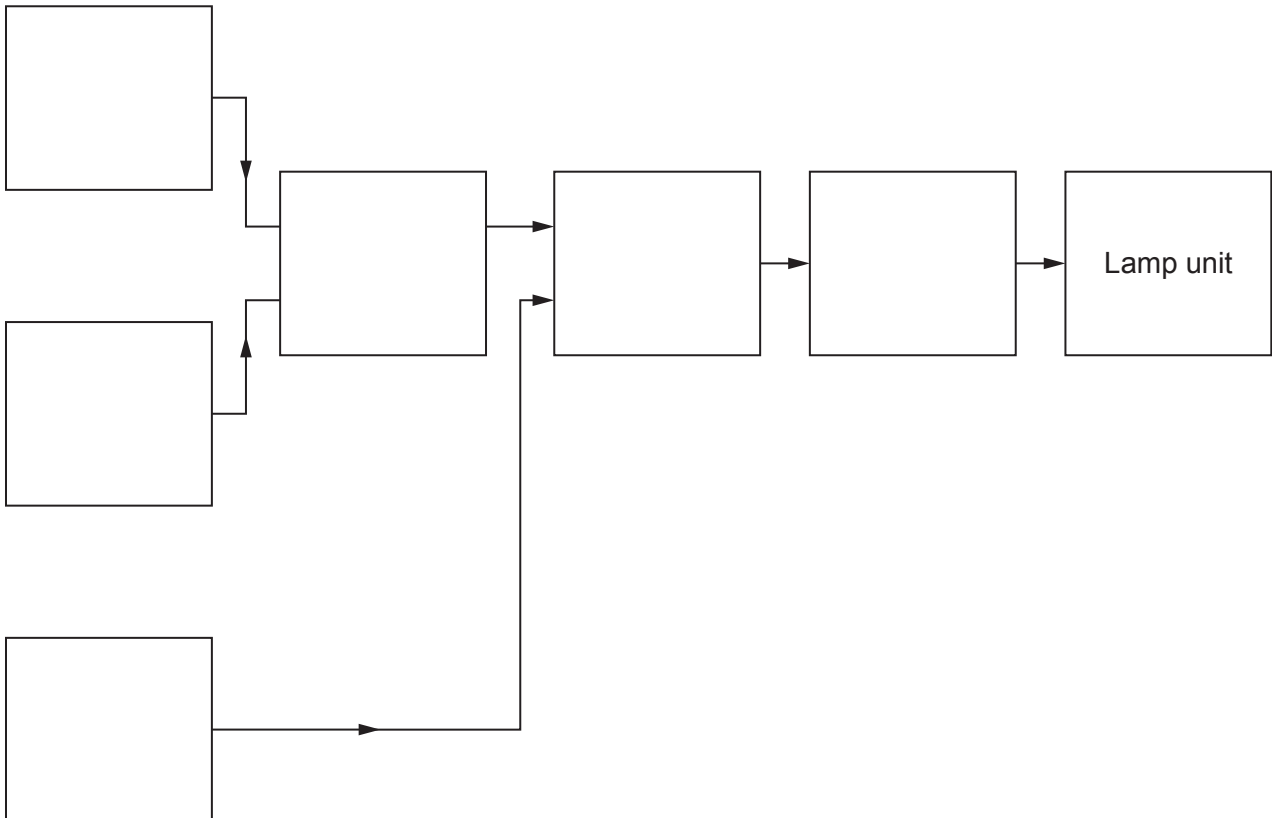


The sensing units behave as follows:

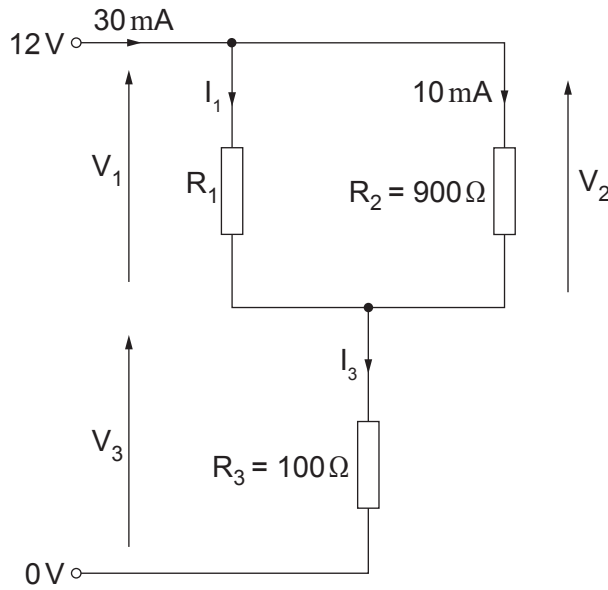
- The moisture sensing unit outputs logic 1 when wet.
- The light sensing unit outputs logic 1 in the dark.
- The temperature sensing unit outputs logic 0 when cold.

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

[6]



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



(i) Determine the values of the following: [2]

$I_1 =$

$I_3 =$

(ii) Calculate the value of V_3 . [3]

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(iii) Calculate the value of V_1 . [2]

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.....

(iv) Calculate the total resistance of the circuit. [3]

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(b) What is the colour code on resistor R_3 ? The tolerance band colour has been completed. [3]

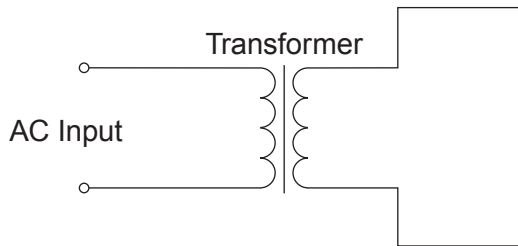
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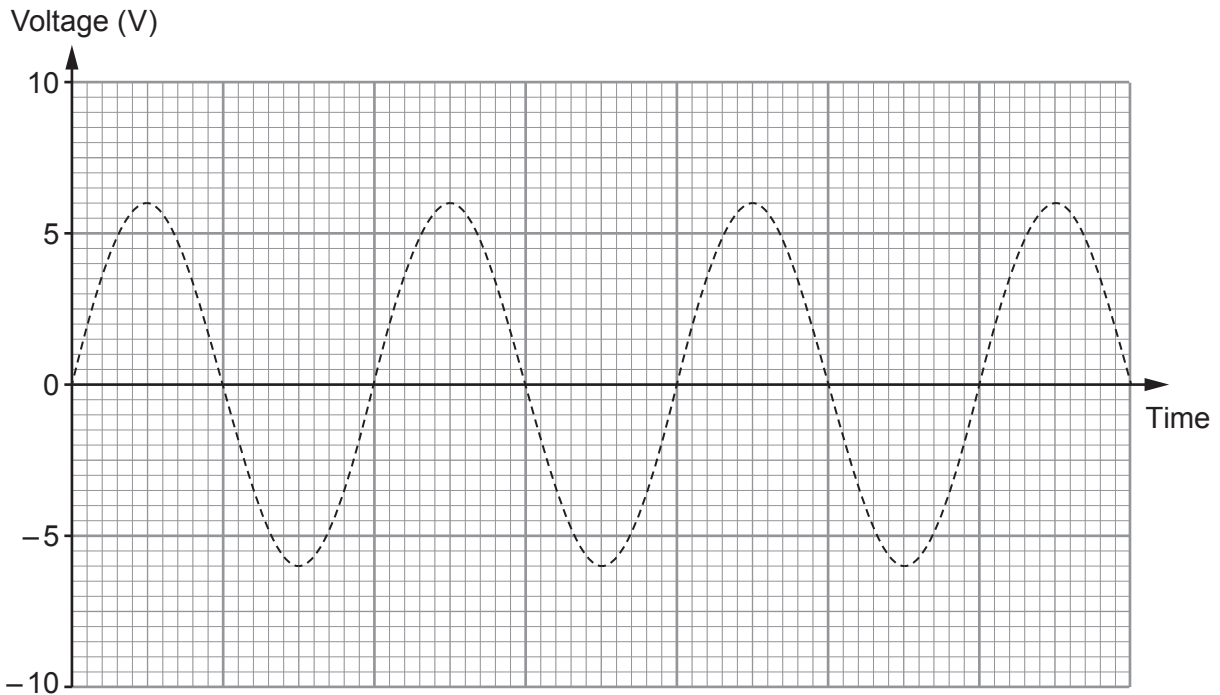


4. The AC output from a transformer needs to be half-wave rectified and connected to a load resistor of $2.7\text{ k}\Omega$.

(a) Complete the circuit diagram of this arrangement. [2]



(b) Sketch a graph of the voltage across the load resistor on the graph below. The transformer output is shown as a dashed line. [2]



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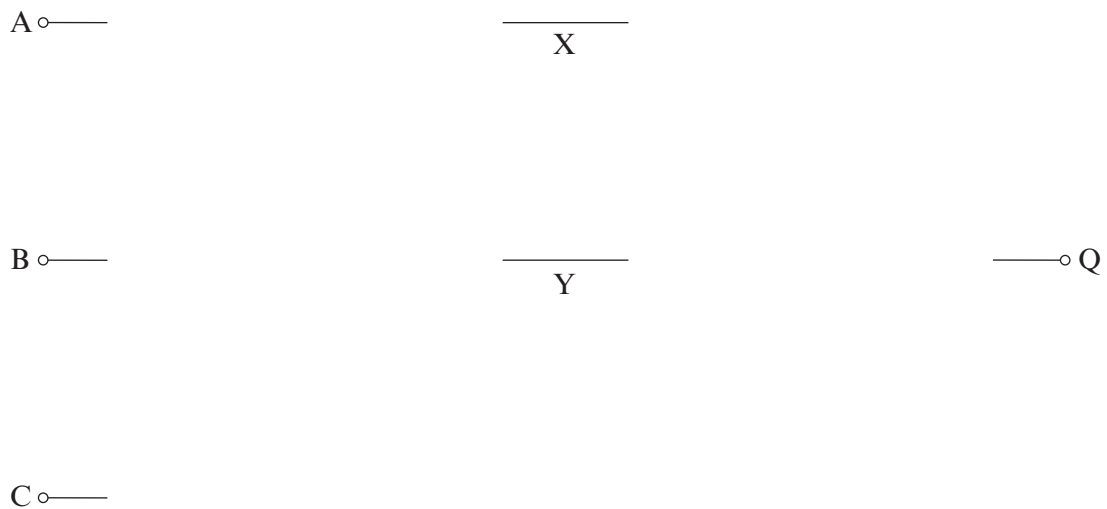
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5. (a) The specification for a logic system is:

- $X = A.C$
- $Y = \bar{B}$
- Output $Q = \overline{X + Y}$

(i) Add the appropriate logic gates and connections to the diagram below to meet the specification: [3]

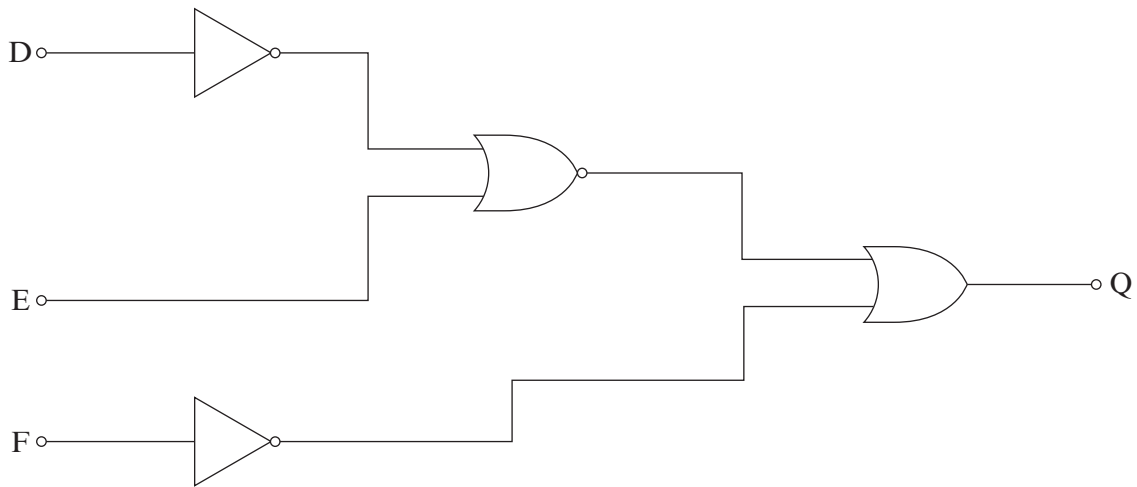


(ii) Complete the following truth table for the specification. [3]

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			



(b) Here is a different logic system.



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

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

(c) In modern cars microcontrollers are used instead of discrete logic gates.

(i) Give **one** use of a microcontroller in a modern car. [1]

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(ii) Describe **one** advantage of using a microcontroller for this use. [2]

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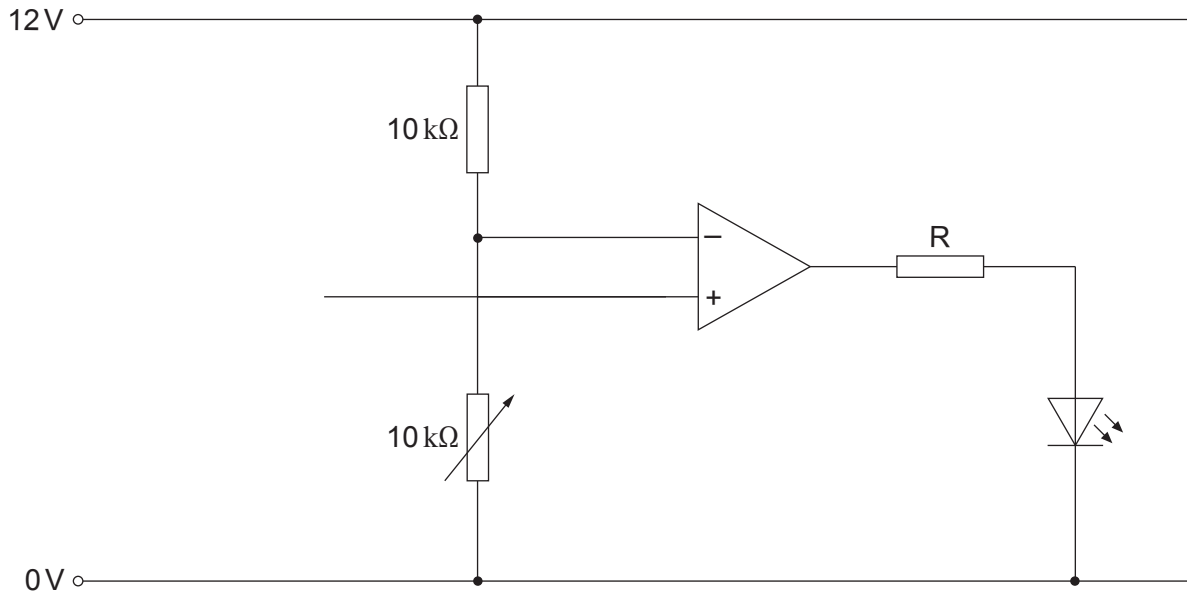
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6. A greenhouse manufacturer has designed a warning system to let gardeners know when the outside temperature falls below 4 °C.

An amber warning LED should come on when the outside temperature falls below 4 °C.

(a) Add the temperature sensing sub-system to complete the circuit. [2]



(b) (i) The amber warning LED has a forward voltage of 2.15V. The **high** output voltage of the comparator is 11.5V. Calculate the ideal value of the resistor R to limit the current through the LED to 19mA. [3]

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(ii) Select an appropriate resistor value from the E24 series to ensure that the current through the LED does not exceed 19mA. [1]

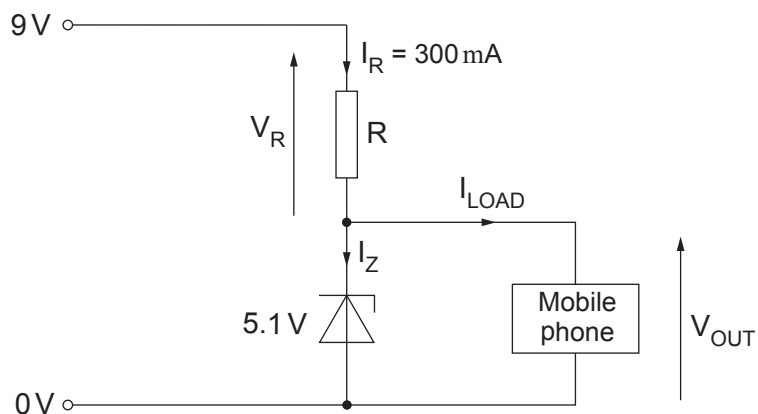
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7. A regulated power supply recharges a mobile phone from a 9V battery. The maximum charging current for the mobile phone is 280 mA.

The circuit is shown below. The 5.1 V zener diode requires a minimum holding current of 12 mA.



- (a) Determine the voltage V_R across resistor R. [1]

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- (b) Calculate the current I_Z through the zener diode when the power supply is providing the maximum charging current. [2]

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- (c) The mobile phone is disconnected from the circuit.
- (i) What is the new current through the zener diode? [1]

- (ii) Calculate the power dissipated in the zener diode. [3]

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(iii) Choose the most suitable 5.1 V zener diode from the following.

[1]

Max power rating	Cost
500 mW	£0.05
1.3 W	£0.07
2 W	£0.20
5 W	£0.31

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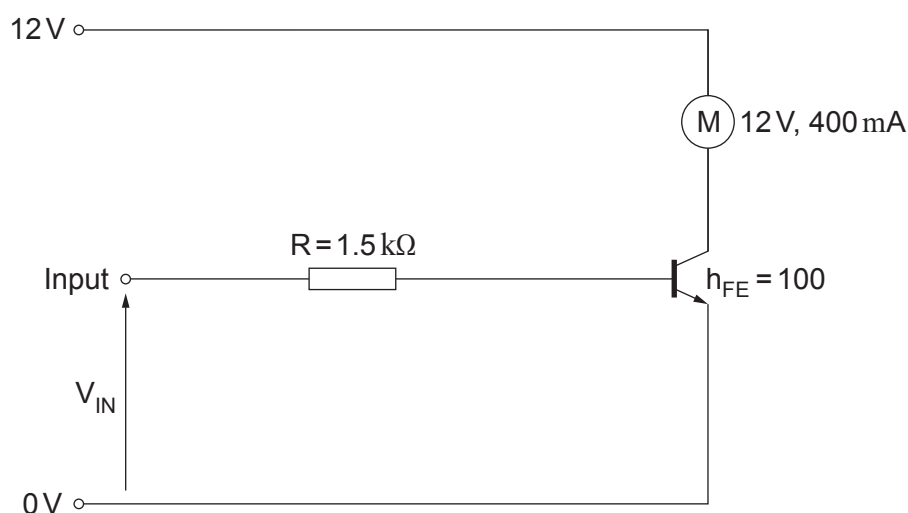
(d) The 9V supply battery is replaced with a 12V battery. What is the new value of V_{OUT} ?

[1]

9



8. The following diagram shows a transistor switching circuit.



(a) The transistor is just saturated. Calculate:

(i) the base current flowing through the $1.5\text{ k}\Omega$ resistor. [4]

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(ii) the voltage across the $1.5\text{ k}\Omega$ resistor. [2]

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(iii) the value of V_{IN} . [2]

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(iv) the power dissipated in the motor.

[3]

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(b) **Add a component** to the circuit diagram opposite to protect the transistor when the motor switches off.

[2]

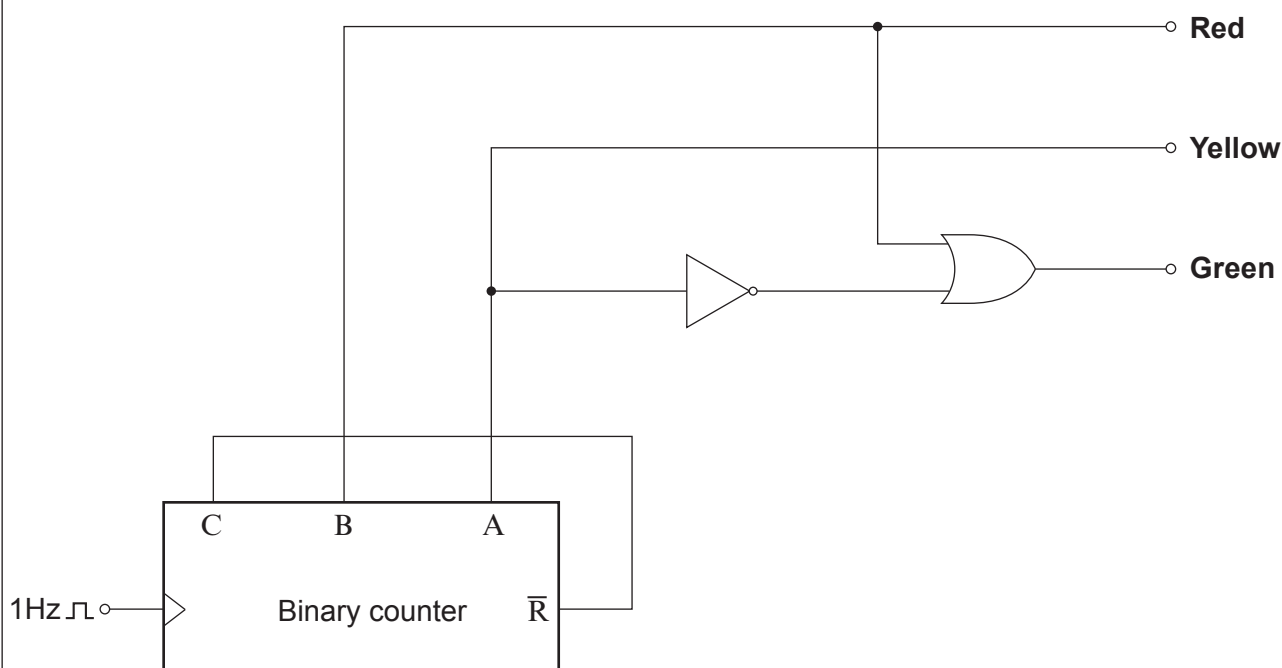
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9. A student was given the task of designing a set of basic traffic lights to produce the outputs shown in the truth table.

B	A	Green	Yellow	Red
0	0	0	0	1
0	1	0	1	1
1	0	1	0	0
1	1	0	1	0

The student's design for the circuit is shown below.



Evaluate the design and its suitability for the task given. Suggest any modifications required.

[6 QER]

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