

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
AS GCE
F611/01
ELECTRONICS
Simple Systems

TUESDAY 12 MAY 2015: Morning
DURATION: 1 hour 30 minutes
plus your additional time allowance
MODIFIED ENLARGED 24pt

Candidate forename						Candidate surname				
Centre number						Candidate number				

Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:
None

OTHER MATERIALS REQUIRED:
Scientific calculator

A calculator may be used for this paper
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READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 90.

Quality of Written Communication will be assessed in this paper.

You are advised to show all the steps in any calculations.

Any blank pages are indicated.

DATA SHEET

Unless otherwise indicated, you can assume that:

op-amps are run off supply rails at +15V and –15V.

logic circuits are run off supply rails at +5V and 0V.

resistance $R = \frac{V}{I}$

power $P = VI$

series resistors $R = R_1 + R_2$

time constant $\tau = RC$

monostable pulse time $T = 0.7 RC$

relaxation oscillator
period $T = 0.5 RC$

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

Boolean Algebra $A \cdot \bar{A} = 0$

$$A + \bar{A} = 1$$

$$A \cdot (B + C) = A \cdot B + A \cdot C$$

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

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

$$A + A \cdot B = A$$

$$A \cdot B + \bar{A} \cdot C = A \cdot B + \bar{A} \cdot C + B \cdot C$$

1 A truth table for a logic system is shown below.

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

- (a) Write a Boolean expression for Q in the truth table.
You do not need to simplify the expression.

Q = _____ [1]

- (b) Draw a logic circuit with the behaviour of this truth table
on Fig. 1.1.
You may use any logic gates you need in your design.

FIG. 1.1

A—

B—

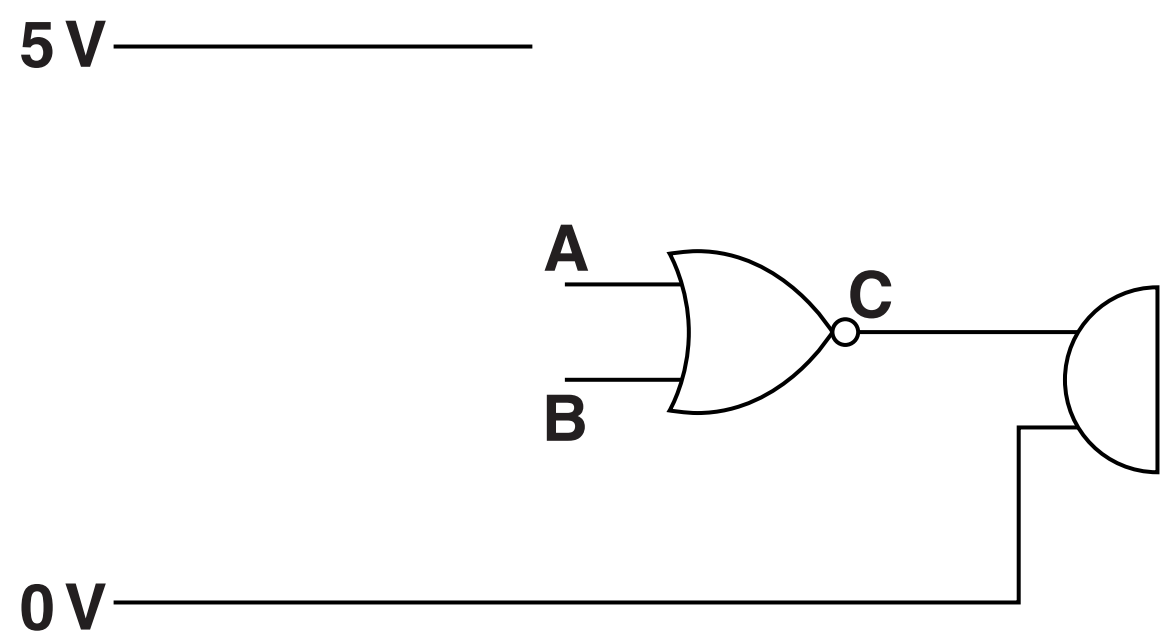
C—

—Q

[2]

2 Fig. 2.1 shows part of a circuit for operating a buzzer.

FIG. 2.1



(a) Name the logic gate in Fig. 2.1.

_____ [1]

(b) Complete the truth table below for the logic gate in Fig. 2.1.

A	B	C

[2]

(c) Write a Boolean expression for C in terms of A and B.

C = _____ [1]

(d) Draw on Fig. 2.1 to show how two push switches and resistors should be connected to the input of the logic gate to produce the logic signals at A and B in your truth table. [3]

(e) State which switches you would press to produce the second line of your truth table.

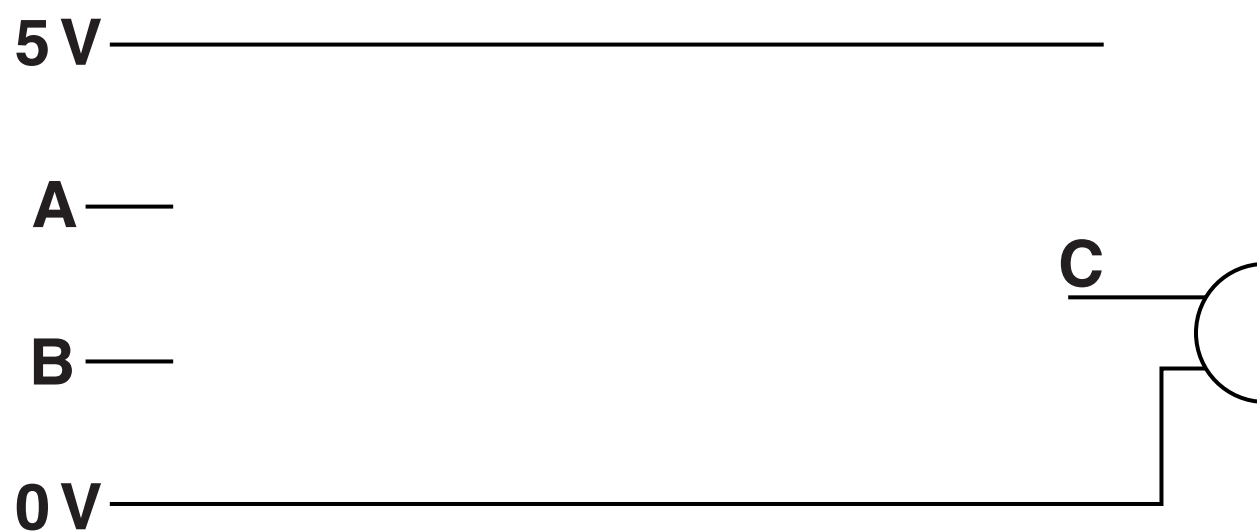
_____ [1]

(f) Explain why the resistors are needed in your design.

_____ [1]

(g) Draw on Fig. 2.2 to show how the logic gate in Fig. 2.1 can be replaced with NAND gates.

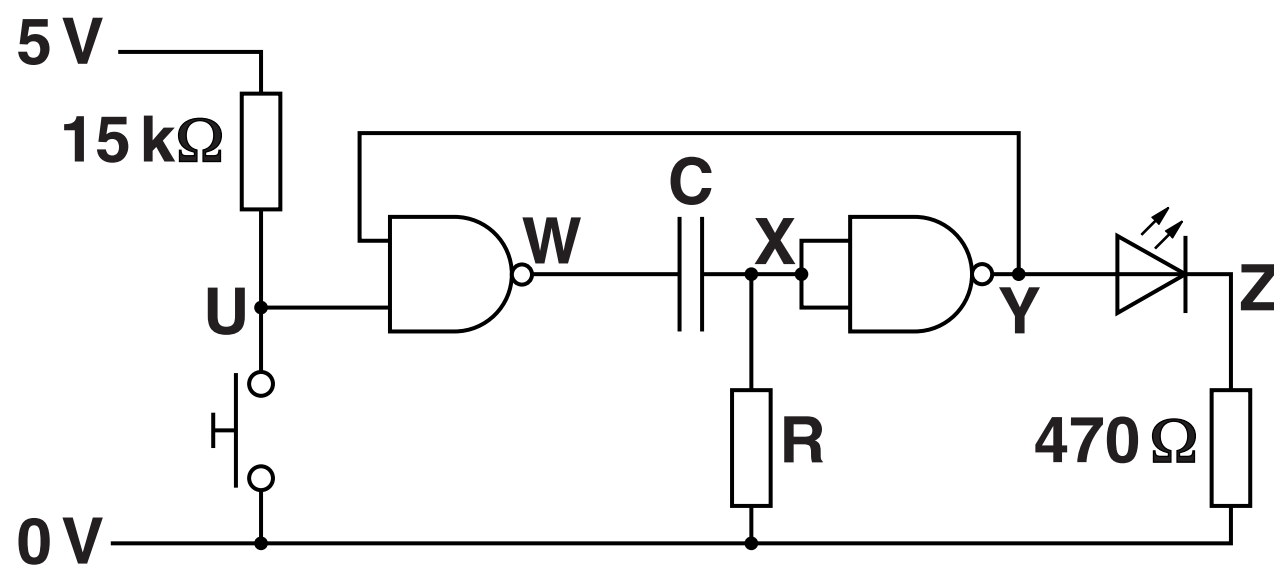
FIG. 2.2



[2]

3 Fig. 3.1 shows a monostable circuit controlling an LED.

FIG. 3.1



(a) The LED in Fig. 3.1 operates with a forward voltage of 1.8V.

Calculate the value of current through the LED when the voltage at Y is 5V.

current through LED = _____ A [2]

(b) Calculate a suitable value for C and R in Fig. 3.1 to give the monostable a period of 20 s.

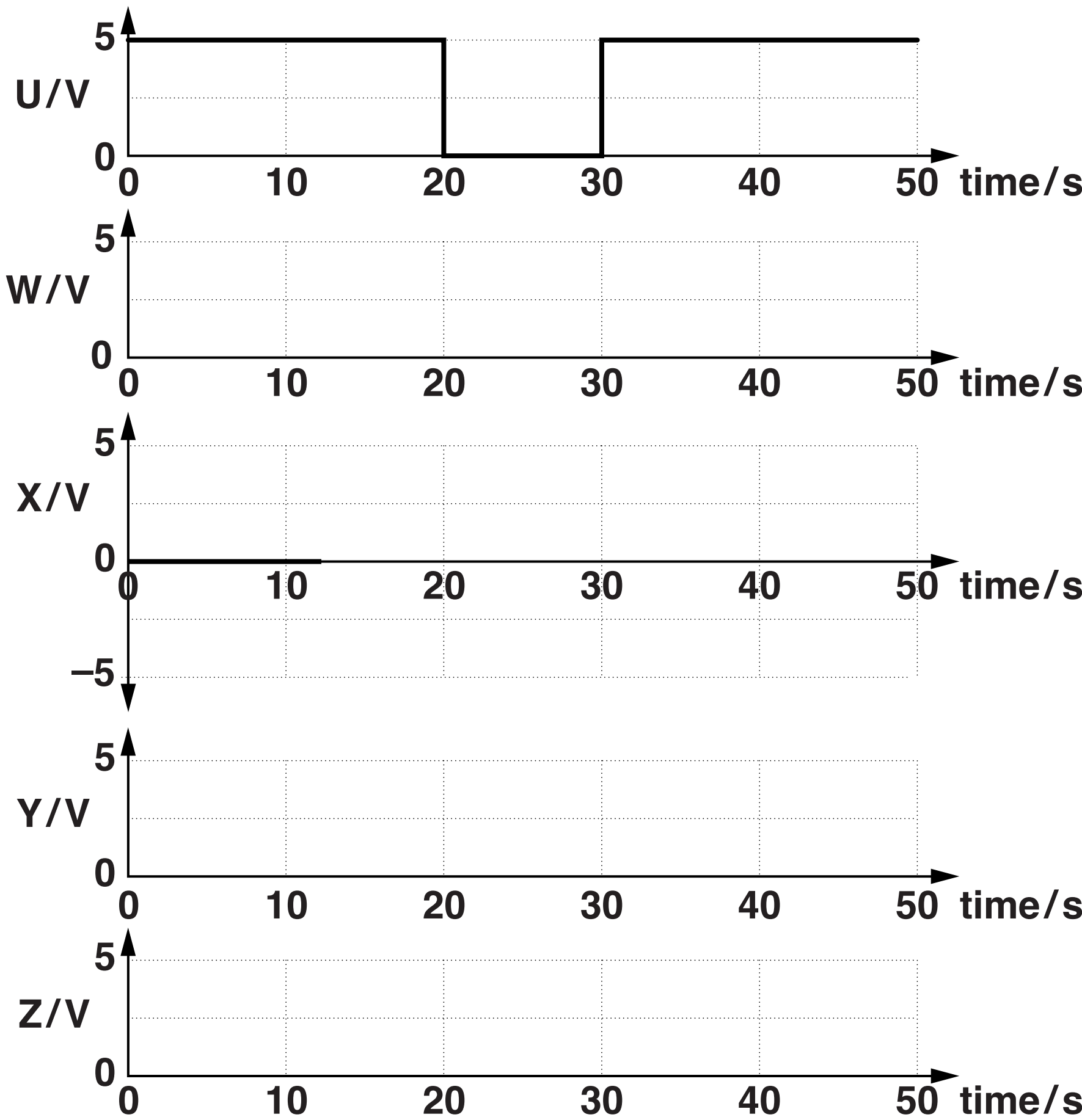
C _____ **R** _____ **[3]**

(c) Describe what happens to the LED when the switch in Fig. 3.1 is briefly pressed.

[3]

(d) Complete the graphs in Fig. 3.2 to show how the voltages at W, X, Y and Z change with time when the value of U changes as shown.

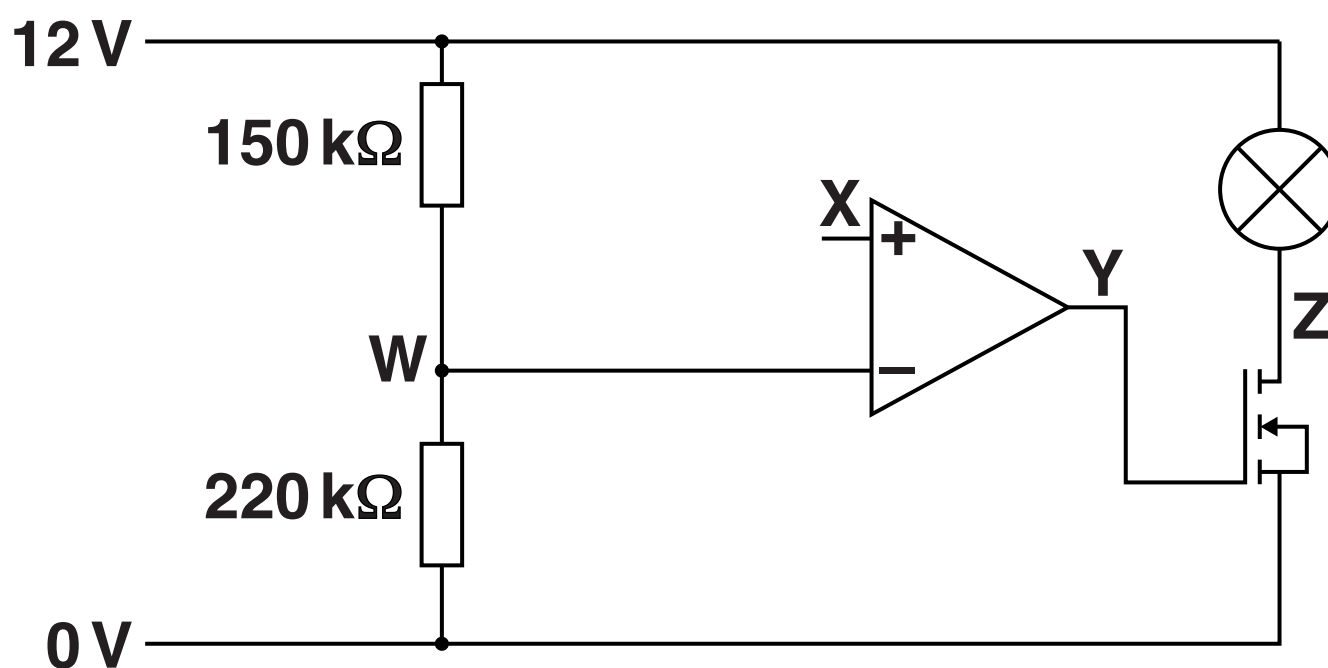
FIG. 3.2



[8]

- 4 Fig. 4.1 shows an incomplete circuit built by a student for controlling a lamp.

FIG. 4.1



- (a) Calculate the voltage at W in the circuit.

voltage at W = _____ V [3]

(b) Draw on Fig. 4.1 to show how a potentiometer should be added to the circuit to vary the voltage at X between 0 V and 12 V. [2]

(c) State and explain what happens to the lamp as the voltage at X is slowly increased from 0V to 12V.

Refer to the voltages at W, X, Y and Z in your answer.

[6]

(d) The lamp is rated at 36W, 12V.

Calculate the current through the lamp when it is on.

current = _____ A [1]

(e) Select the most suitable MOSFET for the circuit in Fig. 4.1 from the table below. Justify your answer.

MOSFET	Max current/ A	Max power/ W	Price
VNP10N07	10	50	90p
STP36NF06L	30	70	39p
2N7000	0.2	0.4	4p
FDN359AN	2.7	0.5	29p
TSM2N7002KCX	0.3	0.2	4p

_____ **[1]**

5 This question is about using the rules of Boolean algebra.

(a) Put a ring around the truth table which matches the Boolean expression.

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

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

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

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

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

[1]

(b) Put a ring around the truth table which matches the Boolean expression.

$P = (\overline{C} \cdot D) \cdot (C + \overline{D})$

C	D	P
0	0	0
0	1	1
1	0	0
1	1	0

C	D	P
0	0	1
0	1	1
1	0	0
1	1	1

C	D	P
0	0	0
0	1	0
1	0	0
1	1	0

C	D	P
0	0	1
0	1	0
1	0	1
1	1	1

[1]

(c) Put a ring around the truth table which matches the Boolean expression.

$R = (\overline{E \cdot \overline{F}}) \cdot F$

E	F	R
0	0	0
0	1	1
1	0	0
1	1	1

E	F	R
0	0	0
0	1	0
1	0	1
1	1	0

E	F	R
0	0	0
0	1	0
1	0	0
1	1	0

E	F	R
0	0	0
0	1	1
1	0	0
1	1	0

[1]

(d) Put a ring around the truth table which matches the Boolean expression.

$S = (\overline{G} + H) \cdot (\overline{G \cdot H})$

G	H	S
0	0	1
0	1	1
1	0	0
1	1	0

G	H	S
0	0	1
0	1	1
1	0	0
1	1	1

G	H	S
0	0	1
0	1	1
1	0	1
1	1	0

G	H	S
0	0	0
0	1	1
1	0	0
1	1	0

[1]

(e) Draw a line from each expression in the left hand column to the equivalent expression in the right hand column.

$$\overline{(p \cdot r) \cdot q}$$

$$\bar{r} \cdot q$$

$$p \cdot \bar{r} \cdot \bar{q}$$

$$(\bar{p} + r) \cdot (p + r) \cdot q$$

$$\bar{p} + r + q$$

$$p \cdot \bar{q} \cdot \bar{r} + \bar{p} \cdot q \cdot r$$

$$(p \cdot q \cdot \bar{r}) + (p \cdot \bar{q} \cdot \bar{r})$$

$$\bar{p} + q$$

$$p \cdot \bar{r} + p \cdot \bar{p}$$

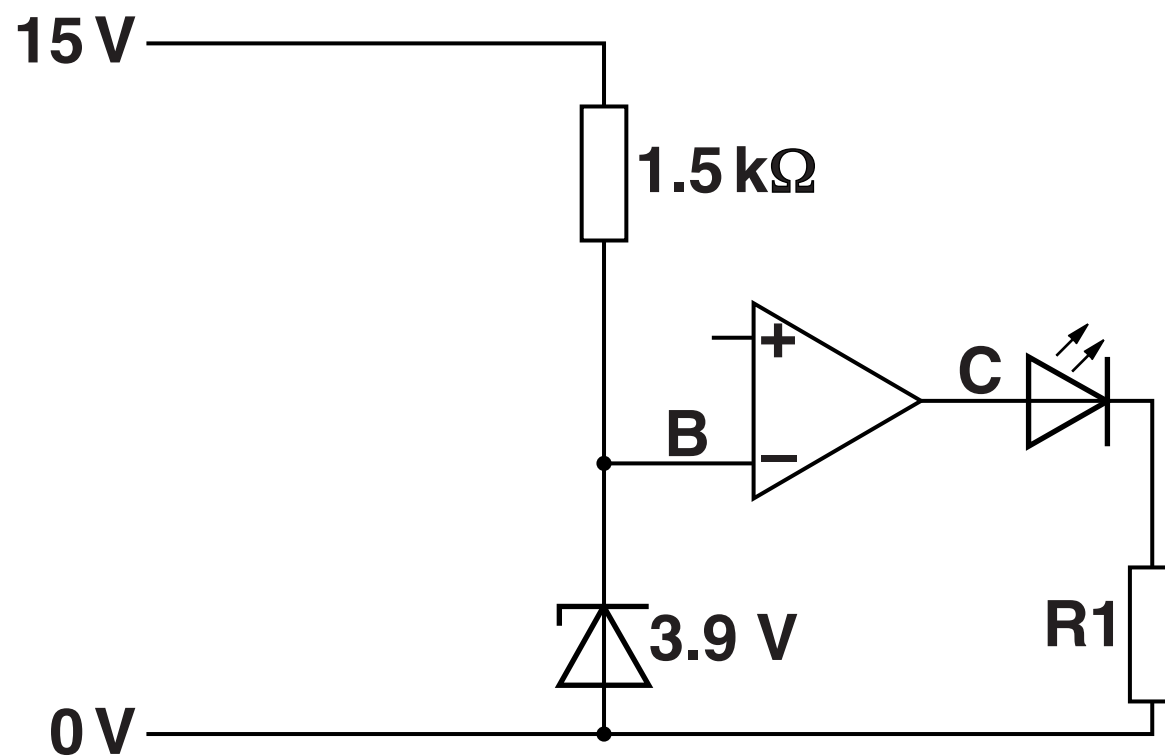
$$(\bar{p} \cdot \bar{q} \cdot \bar{r}) \cdot r + \bar{p} \cdot \bar{q}$$

$$\bar{q}$$

[4]

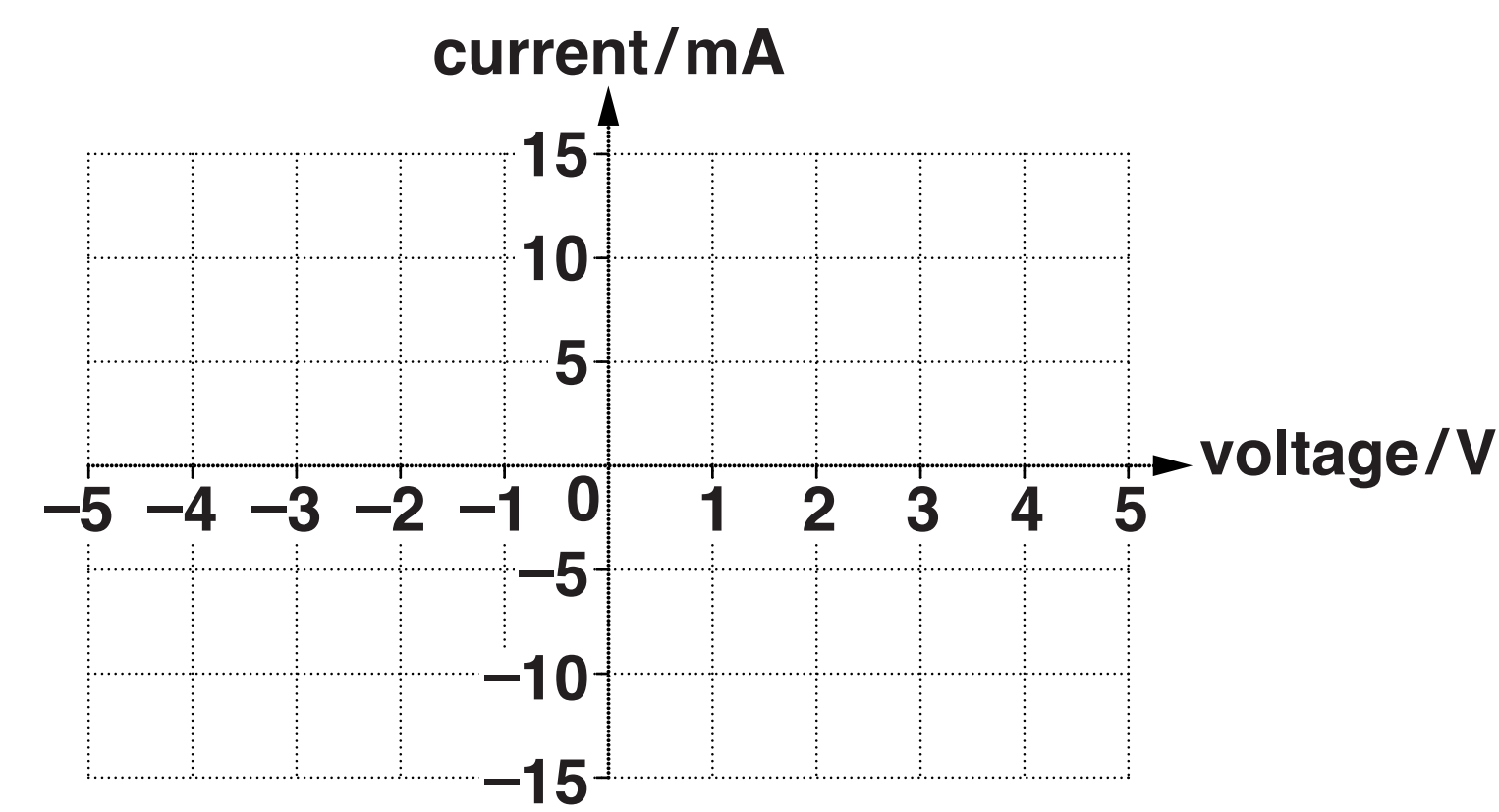
- 6 The diagram in Fig. 6.1 shows an incomplete circuit for turning on an LED in a car to warn that the outside temperature is below 4°C .

FIG. 6.1



- (a) Draw a ring around the zener diode in Fig. 6.1. [1]
- (b) Draw a graph of the current-voltage characteristics of the zener diode on the axes in Fig. 6.2.

FIG. 6.2



[3]

(c) Explain why the zener diode is used in the circuit.

[2]

(d) The LED in Fig. 6.1 will start to glow when the temperature falls to 4 °C.

A thermistor is used to sense the temperature.

(i) Describe the electrical properties of a thermistor.

[2]

(ii) Draw on Fig. 6.1 to show how a fixed resistor R2 and a thermistor are connected to the circuit to make the LED glow when the temperature falls to 4 °C. **[3]**

(iii) The resistance of the thermistor at 4 °C is 3.7 kΩ.

Calculate the value of R2 that will cause the LED to glow at this temperature when the temperature falls to 4 °C.

value of resistor R2 = _____ Ω [3]

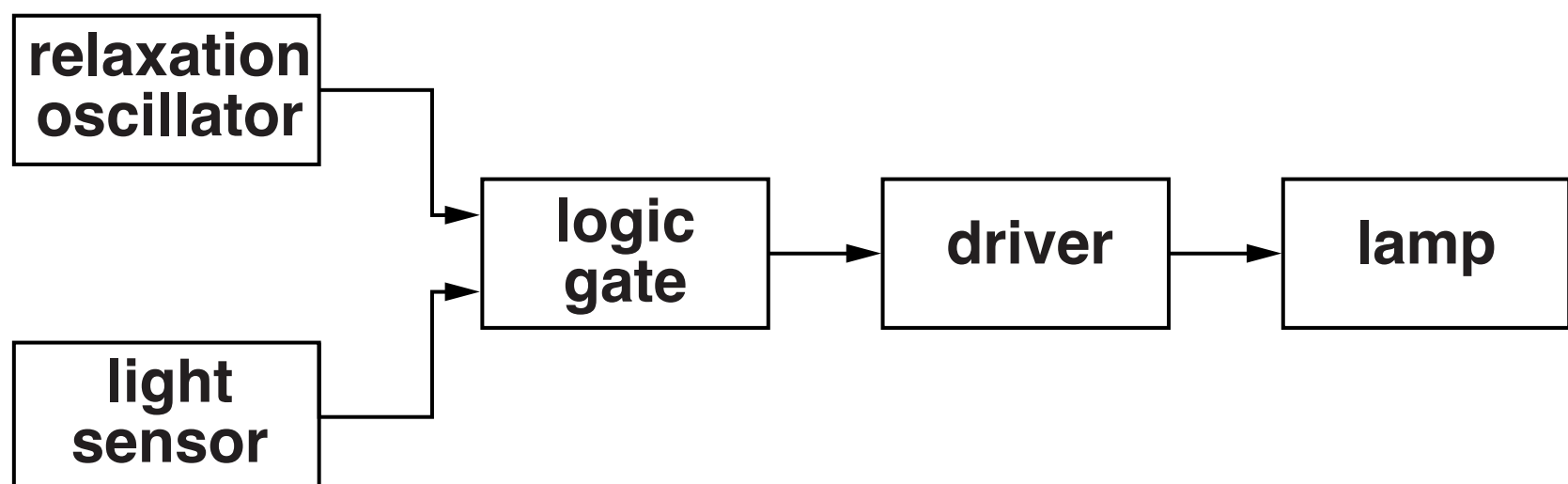
(e) The LED operates at 2.1V, 8mA.

Calculate the value of R1 to make the LED operate correctly.

value of resistor R1 = _____ Ω [2]

- 7 Fig. 7.1 shows a block diagram for a system to make a warning lamp flash at night.

FIG. 7.1



- (a) State the function of the logic gate in Fig. 7.1.

_____ [1]

- (b) Explain why the driver is needed in the block diagram.

_____ [2]

- (c) To make the lamp flash the relaxation oscillator goes high for 0.2 s, low for 0.2 s, high for 0.2 s, low for 0.2 s and keeps repeating this behaviour.

- (i) Calculate the frequency of the relaxation oscillator.

frequency = _____ Hz [1]

**(ii) Draw the circuit diagram of the relaxation oscillator in the space below.
Show all component values.**

[6]

**(d) The logic gate in the system shown in Fig. 7.1 is a NAND gate.
Explain how this gate allows the system to respond to make the warning lamp flash at night.**

[2]

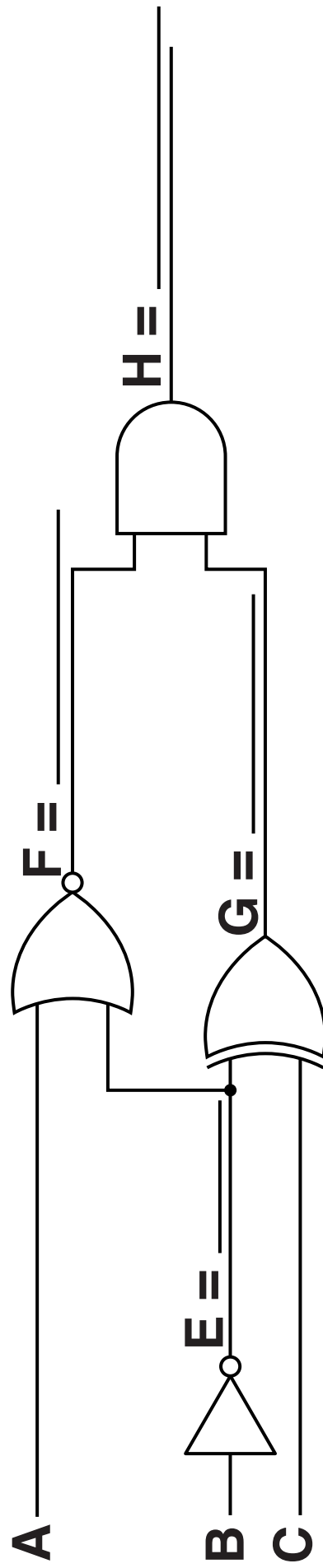
- 8 Fig. 8.1 opposite shows a logic system.
- (a) On Fig. 8.1 write the Boolean expression for the output of each gate using ONLY the letters A, B and C. You do not need to simplify your expressions. [4]
- (b) Complete the truth table below for the logic system in Fig. 8.1.

A	B	C	E	F	G	H
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

[4]

Quality of written communication [3]

FIG. 8.1



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