O

JURONGVILLE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
Secondary 4 Express

STUDENT NAME			
CLASS		INDEX NUMBER	

ELECTRONICS

6063/01

Paper 1

13 AUG 2024

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces on all the work you hand in.
Write in dark blue or black pen.
You may use pencil for drawing diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions.

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 100.

DO NOT OPEN THE BOOKLET UNTIL YOU ARE TOLD TO DO SO

For Examiner's Use
100

Setter: Mdm Wong Ruting

This document consists of **22** printed pages.

DATASHEET

RESISTOR COLOUR CODE

1st Colour Band 1st Digit	2nd Colour Band 2nd Digit	3rd Colour Band Multiplier	4th Colour Band Tolerance
Black 0	Black 0	Black 0	Gold ± 5%
Brown 1	Brown 1	Brown 1	Red ± 2%
Red 2	Red 2	Red 2	
Orange 3	Orange 3	Orange 3	
Yellow 4	Yellow 4	Yellow 4	
Green 5	Green 5	Green 5	
Blue 6	Blue 6	Blue 6	
Violet 7	Violet 7	Violet 7	
Grey 8	Grey 8	Silver 0.01	
White 9	White 9	Gold 0.1	

STANDARD VALUES FOR RESISTORS (E24 SERIES)
1.0 1.1 1.2 1.3 1.5 1.6 1.8 2.0 2.2 2.4 2.7 3.0 3.3
3.6 3.9 4.3 4.7 5.1 5.6 6.2 6.8 7.5 8.2 9.1 and multiples of ten.

FORMULAE

Astable and monostable generators using 555 timers

Monostable mode — Period T = 1.1RC

Astable mode frequency

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

Bipolar Junction Transistor (BJT)

Current gain

$$\beta = \frac{Collector\ Current}{Base\ Current}$$

Voltage gain (for voltage-divider biased CE amplifier, emitter resistor unbypassed)

$$\cong -\frac{R_C}{R_E}$$

Table on Boolean algebra

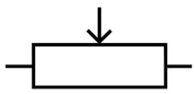
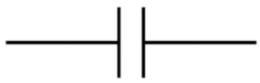
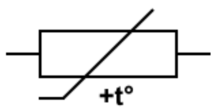
Single-variable theorems	Laws of Complementation	• $\overline{0} = 1$ • $\overline{1} = 0$ • $\overline{\overline{A}} = A$
	AND Laws	• $A \cdot 0 = 0$ • $A \cdot 1 = A$ • $A \cdot A = A$ • $A \cdot \overline{A} = 0$
	OR Laws	• $A + 0 = A$ • $A + 1 = 1$ • $A + A = A$ • $A + \overline{A} = 1$
Multivariable theorems	Commutative Laws	• $A + B = B + A$ • $A \cdot B = B \cdot A$
	Associative Laws	• $A + (B + C) = (A + B) + C = A + B + C$ • $A \cdot (B \cdot C) = (A \cdot B) \cdot C = A \cdot B \cdot C$
	Distributive Laws	• $A \cdot (B + C) = A \cdot B + A \cdot C$ • $(A + B) \cdot (C + D) = A \cdot C + B \cdot C + A \cdot D + B \cdot D$
	Absorption Laws	• $A + A \cdot B = A$ • $A \cdot (A + B) = A$ • $A + \overline{A} \cdot B = A + B$ • $A \cdot (\overline{A} + B) = A \cdot B$
	DeMorgan's Theorems	• $(\overline{A + B}) = \overline{A} \cdot \overline{B}$ • $(\overline{A . B}) = \overline{A} + \overline{B}$

SECTION A

Answer **all** questions in this section.

1 Complete Table 1.1**.**

Table 1.1

	Component Name	Component Symbol
(a)		
(b)	PNP transistor	
(c)		
(d)	Ammeter	
(e)	SPDT Switch	
(f)		

[6]

2 Complete Fig. 2.1 by labelling the colour bands for a 560 kΩ resistor.

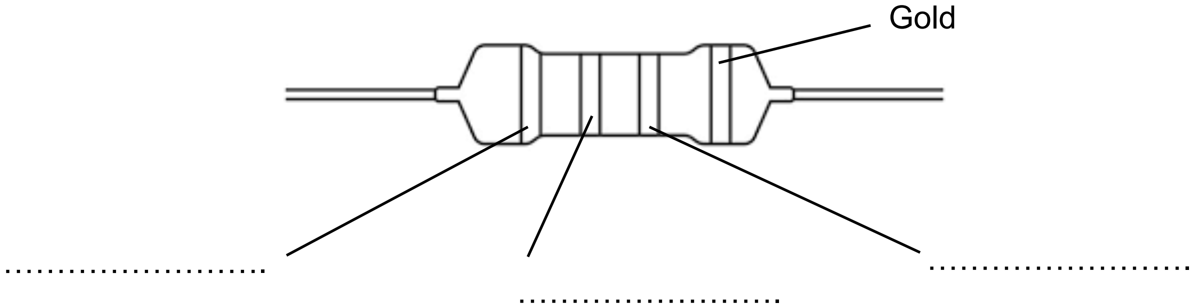


Fig. 2.1

[3]

3 Complete Table 3.1 by converting each measured value.

Table 3.1

Measured value	Converted value
1800 µA	A
470 pF	nF
0.5 mV	µV
56000 Ω	kΩ

[4]

4 Fig. 4.1 shows current entering and leaving the nodes.

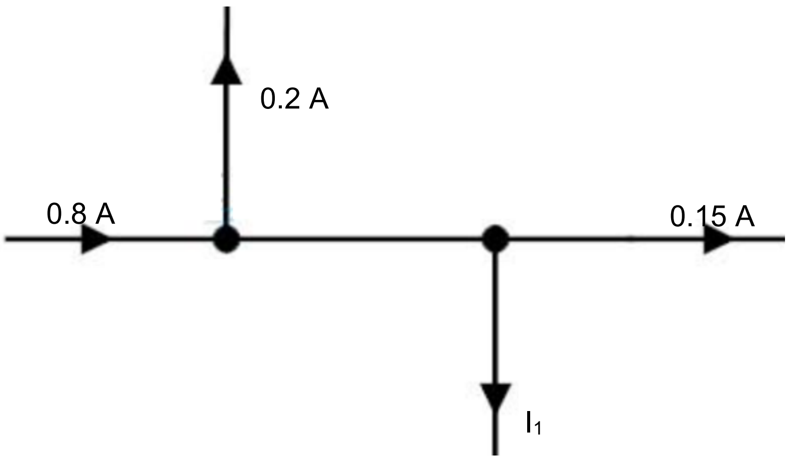


Fig. 4.1

Calculate current, $\mathbf{I_1}$.

…………………………………………………………………………………………………… [1]

5 Fig. 5.1 shows a resistor network.

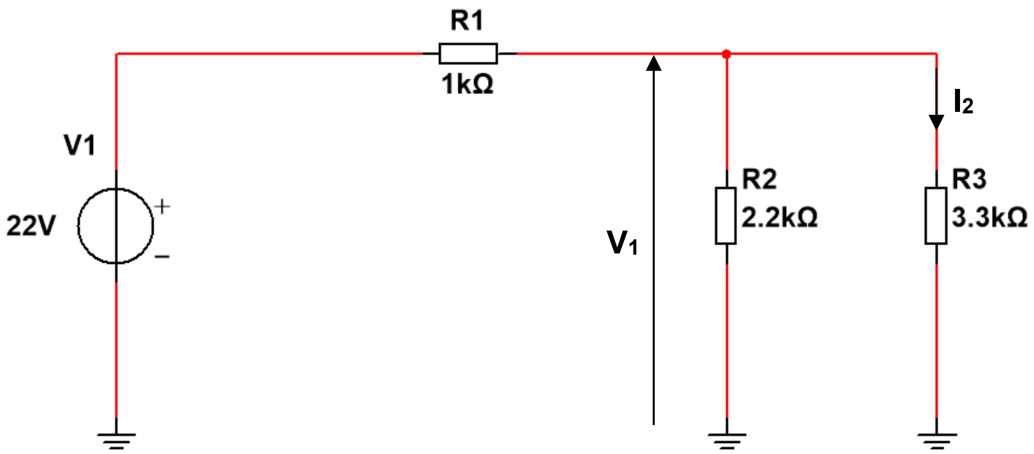


Fig. 5.1

(a) Calculate the voltage $\mathbf{V_1}$.

.... [4]

(b) Using the voltage from part **(a)**, calculate the current flowing through $\mathbf{I_2}$.

.... [2]

6 **(a)** State what is a non-periodic signal.

……

…… [1]

(b) On Fig. 6.1, draw a non-periodic signal.

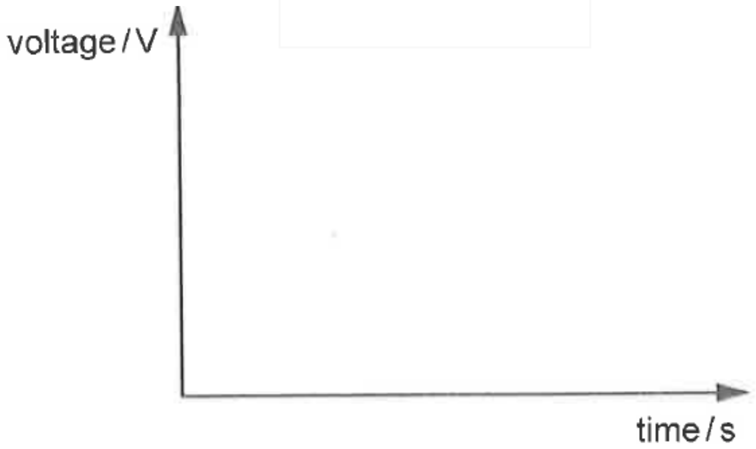


Fig. 6.1

[1]

(c) Determine the duty cycle of the rectangular waveform shown in Fig. 6.2.

Fig. 6.2

…… [2]

7 Fig. 7.1 shows a circuit using bulbs and diodes.

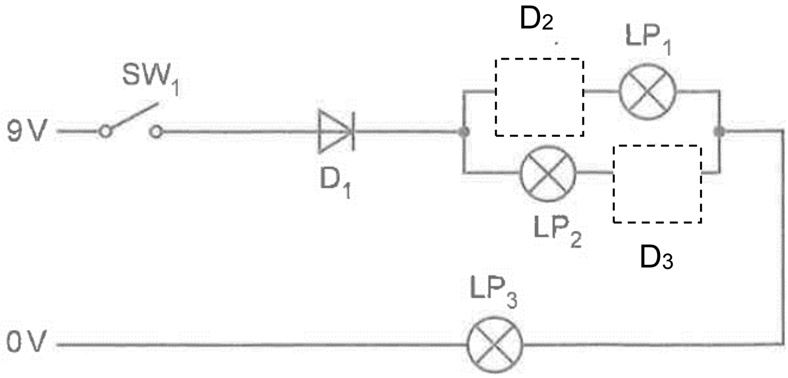


Fig. 7.1

Table 7.1 shows the state of the bulb when SW_1 is closed.

Table 7.1

Bulb	**State ON/OFF**
LP_1	OFF
LP_2	ON
LP_3	ON

(a) Complete the circuit diagram in Fig. 7.1, showing how the diodes D_2 and D_3 should be arranged to achieve the results shown in Table 7.1.

[2]

(b) How is D_1 biased in Fig. 7.1?

………………………………………………………………………………………………….…. [1]

(c) In Fig. 7.2, complete the *I*-*V* graph for a practical diode.

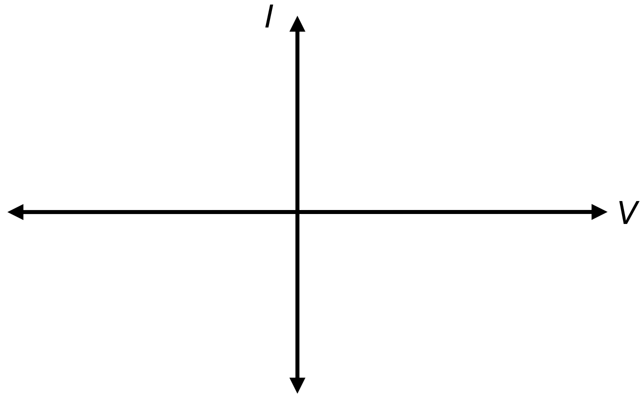


Fig. 7.2 [2]

(d) Explain why the semiconductor diode is a non-ohmic conductor.

………

………

…… [2]

8 **(a)** Find the binary-coded decimal.

0010 + 1000.0001 = …………………………………………………… [1]

(b) List **two** advantages of digital systems over analogue systems.

1 ………

………

2 ………

………[2]

9 Fig. 9.1 shows a logic diagram constructed by an electronics student.

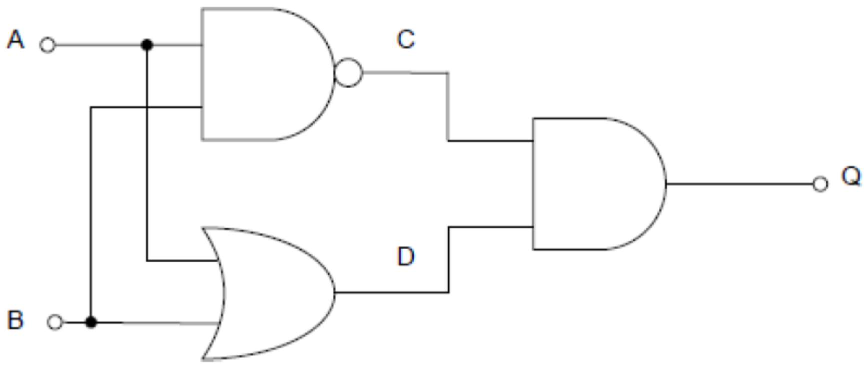


Fig. 9.1

(a) On Table 9.1, complete the truth table for this logic diagram.

Table 9.1

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

[2]

(b) State the Boolean expressions for the logic signals at C, D and Q in terms of inputs A and B.

C = ... [1]

D = ... [1]

Q = ... [2]

SECTION B

Answer **all** questions in this section.

10 Fig. 10.1 shows a coolant tank inside the car engine.

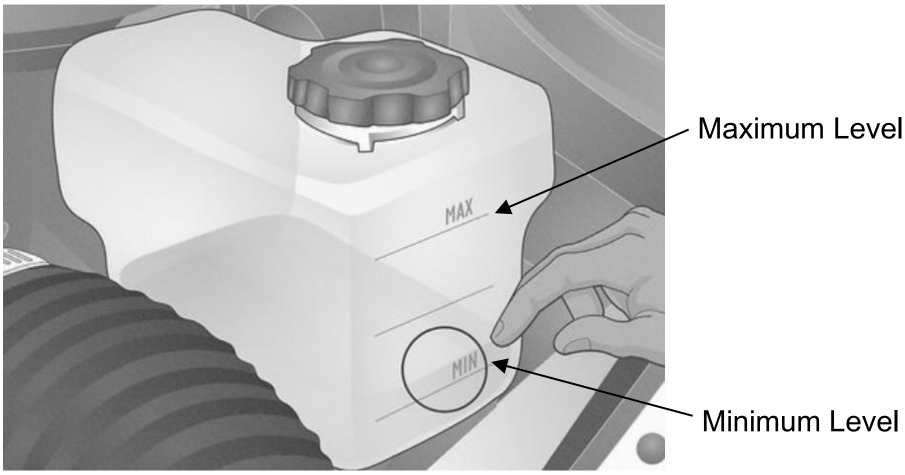


Fig. 10.1

The block diagram and circuit diagram of the coolant level indicator system are shown in Fig. 10.2. An alarm is triggered when the coolant liquid drops below the minimum level.

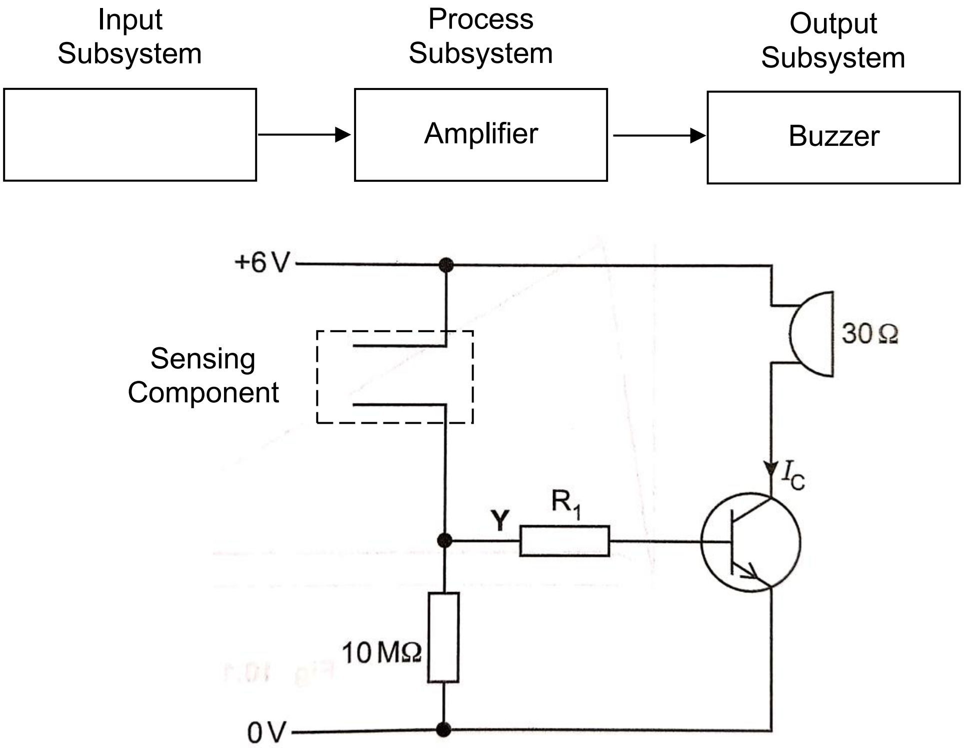


Fig. 10.2

(a) On Fig. 10.2, state the sensing component used in the Input Subsystem of the coolant level indicator system. [1]

(b) Given that the transistor has a $V_{CE(sat)}$ of 0.2 V, calculate the voltage across the buzzer in Fig. 10.2 when the transistor is fully saturated.

.... [1]

(c) Calculate $\mathbf{I_C}$ when the transistor is fully saturated.

.... [2]

(d) To drive current $\mathbf{I_C}$ calculated in part **(c)**, a base current of 2 mA is required. Calculate the gain of the transistor.

.... [2]

(e) **(i)** Table 10.1 shows some transistors.
Tick a transistor that would be suitable for use in the circuit shown in Fig. 10.2.

Table 10.1

Transistor	ß	Max I_c (A)	Suitable (√)
2N1975	15	0.2	
2N1605	40	0.1	
KSP44	45	0.3	
2N3904	100	0.2	

[1]

(ii) State **two** reasons for your choice of transistor.

1 ....

.... [1]

2 ....

.... [1]

(f) The sensing part of the circuit in Fig. 10.2 is a voltage divider between the sensing component and the 10 MΩ resistor.
When the coolant liquid reaches the low level, the resistance of the sensing component becomes 2.5 MΩ. Calculate the voltage at **Y**.

.... [2]

(g) The transistor in Fig. 10.2 saturates with a base voltage V_{BE} of 0.7 V.
Use the voltage at **Y** to calculate the voltage across R_1.

.... [1]

(h) The buzzer is replaced with an electromechanical relay.
Complete the circuit Fig. 10.3 to show how:
- the electromechanical relay can be wired.
- the electromechanical relay can be protected from voltage spike.

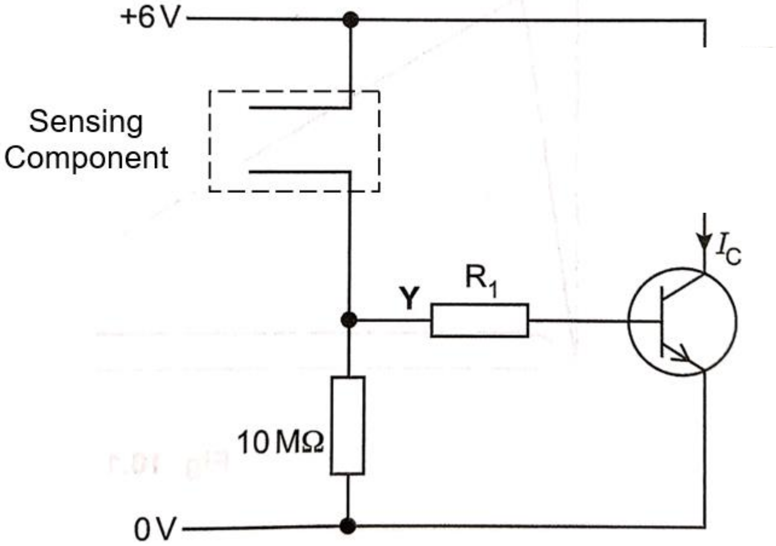


Fig. 10.3

[2]

(i) The base current is too small to drive the transistor in Fig. 10.3 into saturation to turn on the electromechanical relay.
Suggest a suitable solution that can overcome this.

.... [1]

15m

11 Fig. 11.1 shows part of an automatic cooler fan system in a bus.

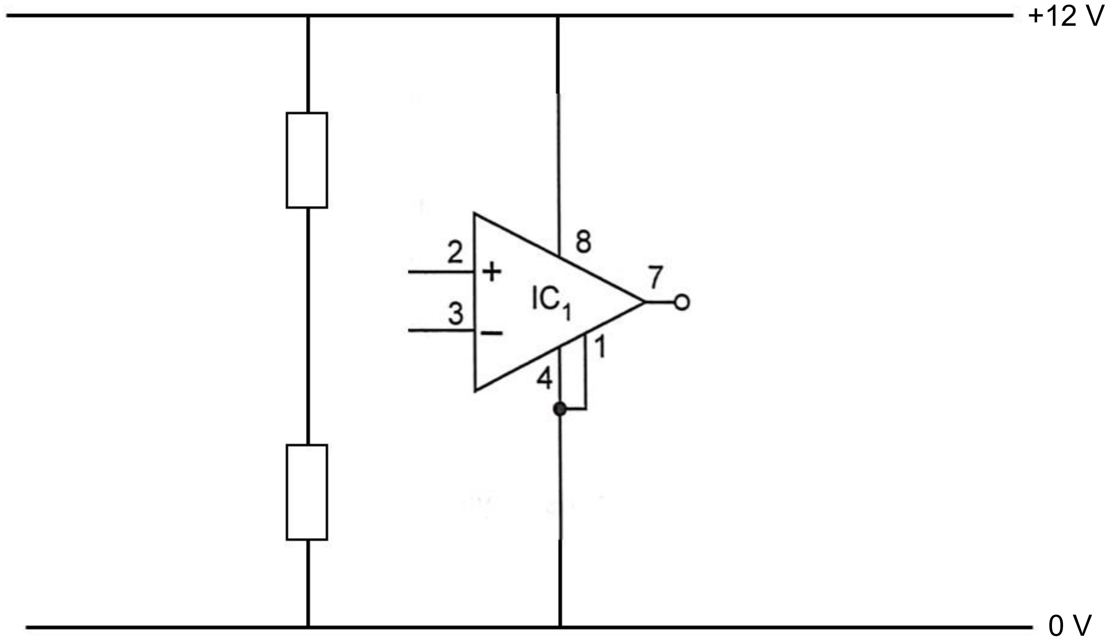


Fig. 11.1

(a) Name the component IC_1 used in Fig. 11.1.

.... [1]

(b) Complete the circuit in Fig. 11.1 so that:

- Reference voltage at the non-inverting pin is set to 8 V. Include suitable values.
- Voltage divider of thermistor and 10 kΩ resistor at the inverting pin.
- Output is HIGH when the surrounding temperature is warm.

[4]

(c) Explain how the component IC_1 causes the output to be high when the surrounding temperature in the bus is warm.

....

....

....

.... [2]

(d) A fan system is connected to the circuit in Fig. 11.1 as shown below.

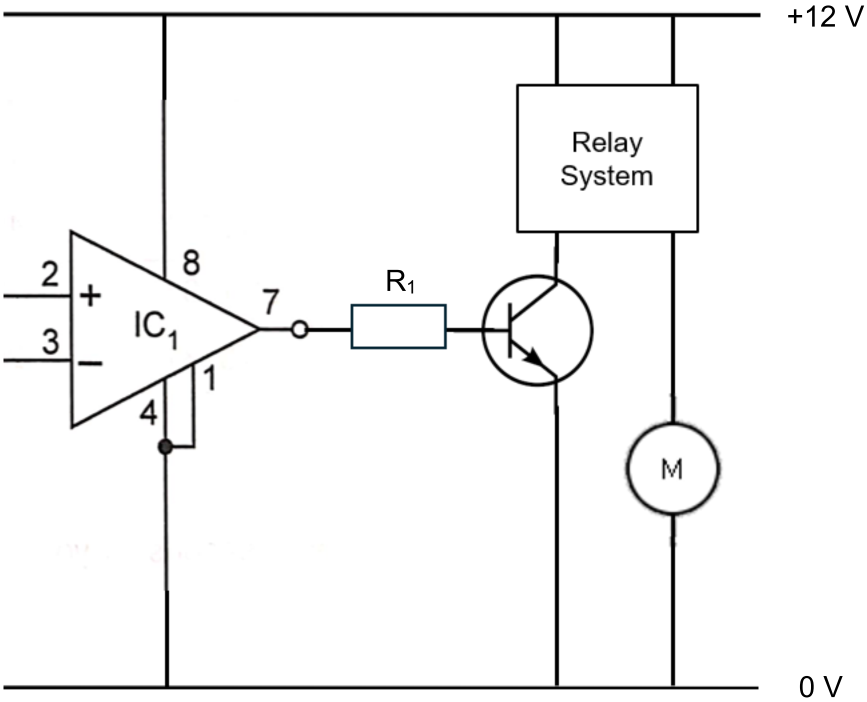


Fig. 11.2

(i) Explain how the fan system works when there is a **high** output at Pin 7.

………

………

………

…………………………………………………………………………………………………… [3]

(ii) State the purpose of $\mathbf{R_1}$ in Fig. 11.2.

………

…………………………………………………………………………………………………… [1]

(e) Complete Fig. 11.3 to show how the AND gates can be wired to give a three input AND gate.

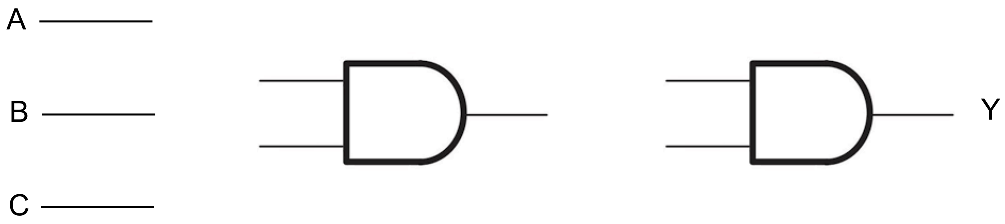


Fig. 11.3

[1]

(f) Fig. 11.4 shows a K-map.

C \ AB	00	01	11	10
0		1	1	
1			1	1

Fig. 11. 4

State the simplified Boolean formula.

.... [3]

15m

12 Fig. 12.1 shows the block diagram of the fridge door alarm system.

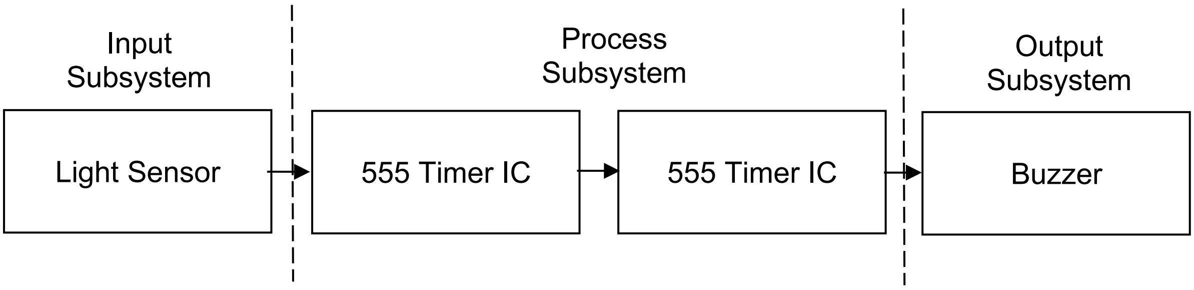
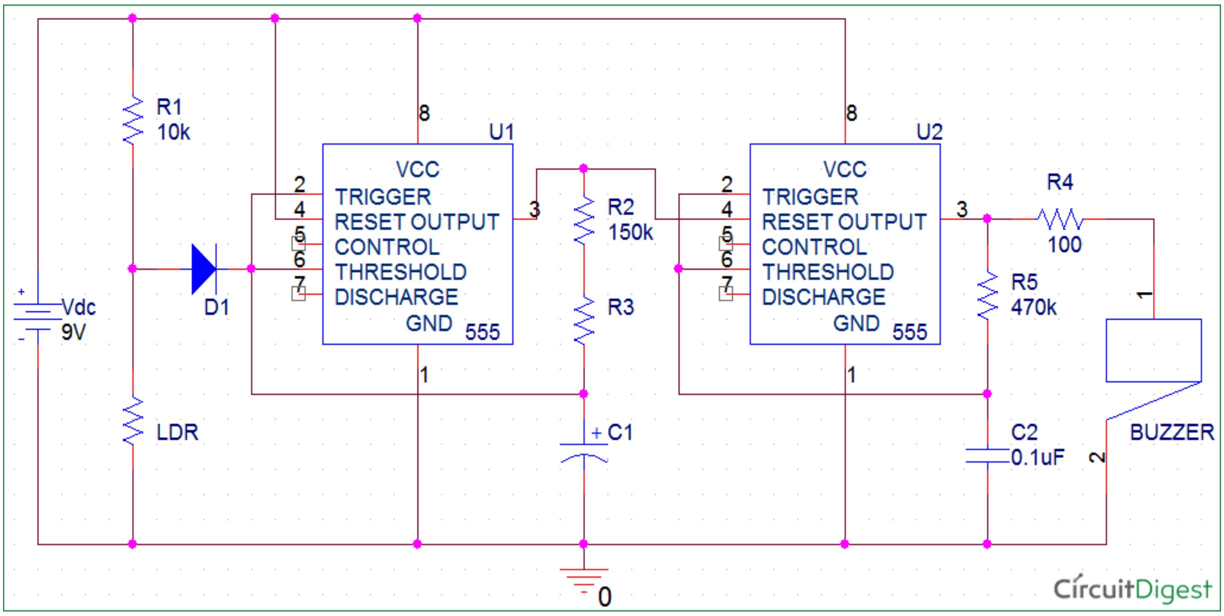


Fig. 12.1

Fig. 12.2 shows the fridge door alarm system circuit diagram.



Source: https://circuitdigest.com/electronic-circuits/fridge-door-alarm-circuit-diagram

Fig. 12.2

Fig. 12.3 shows the pin out of 555 Timer IC.

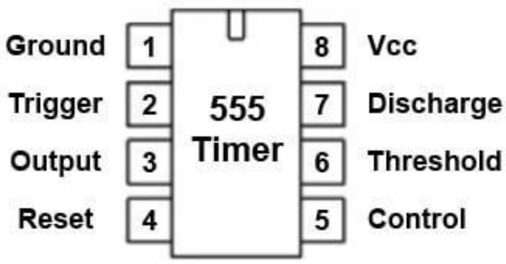


Fig. 12.3

(a) State the mode of operation for both 555 Timer ICs.

.... [1]

(b) Explain how the fridge door alarm system works when the door is opened.

……

……

……

……

……

………………………………………………………………………………………………… [4]

(c) The formula for time delay for the buzzer to be triggered is Time = 1.1 x (R_2 + R_3) x C_1.
The buzzer is to sound when the door is opened for at least 30 seconds.
The value of R_2 is 150 kΩ. Suggest suitable component values of R_3 and C_1 from E24 Series.
Show your working clearly. Your answer must include units.

………………………………………………………………………………………………… [4]

(d) On Fig. 12.4, draw the voltage signal at Pin 2, voltage across C_1, when the door is opened for at least 30 seconds. Assume that C_1 is uncharged initially. Include all necessary values.

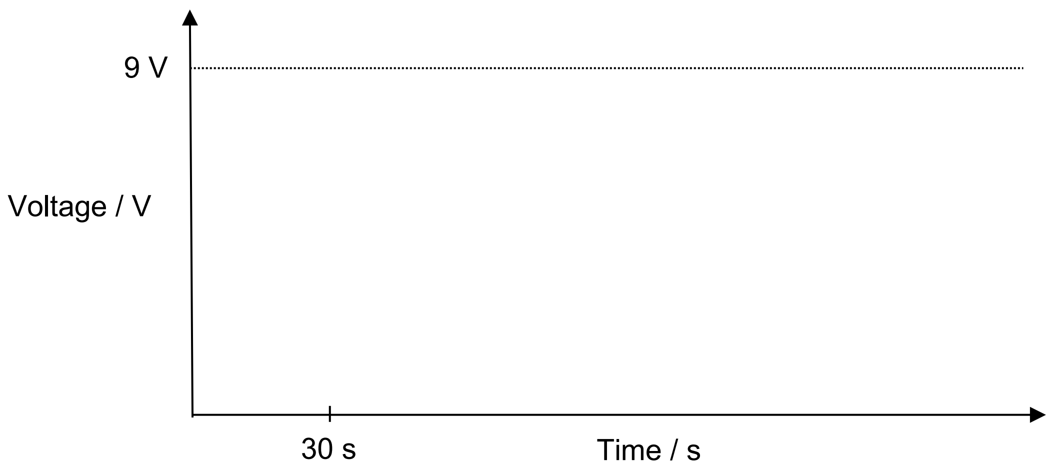


Fig. 12.4

[3]

(e) The 150 kΩ resistor from part **(c)** is unavailable.
On Fig. 12.5, circle the correct method of connecting two resistors to achieve the total value of 150 kΩ.

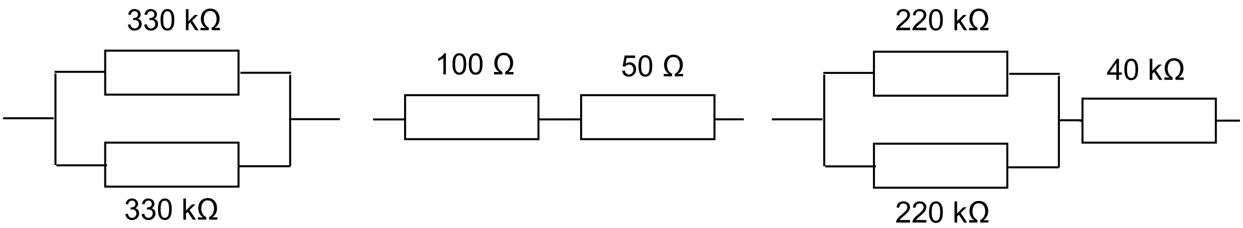


Fig. 12.5

[1]

(f) When the circuit was tested with values calculated from part **(c)**, the timing was different from the calculated 30 seconds.
Explain possible reasons for this.

1 ....

.... [1]

2 ....

.... [1]

15m

13 Fig. 13.1 shows the system diagram of a circuit being developed to measure the speed of a car travelling inside the tunnel.

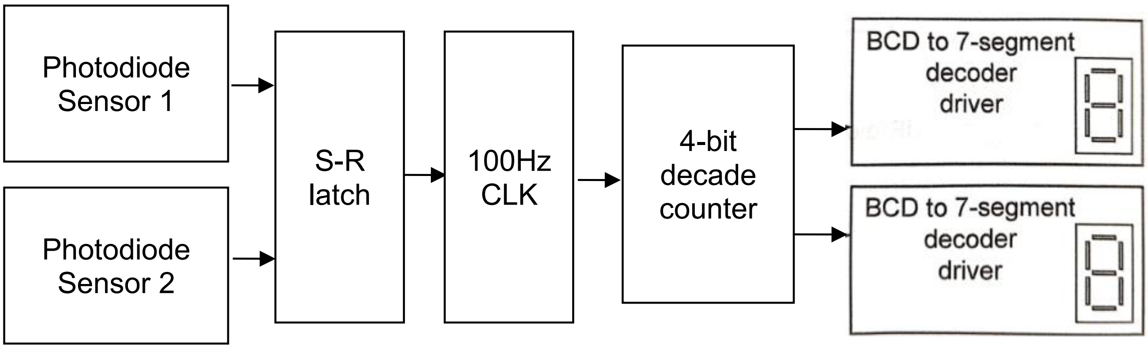


Fig. 13.1

Fig. 13.2 shows how the system will be set up to measure the speed of the car.

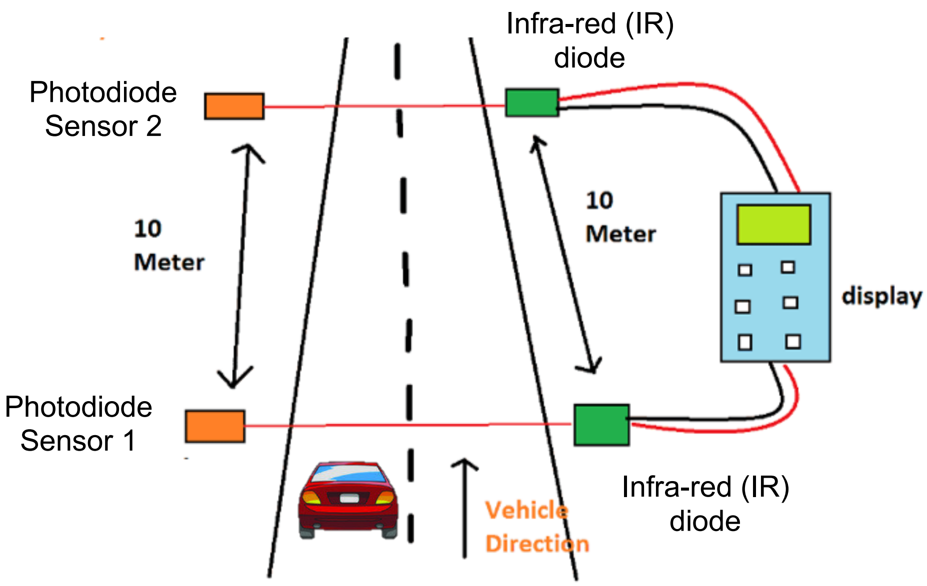


Fig. 13.2

(a) Fig. 13.3 shows one of the sensor subsystems.
On Fig.13.3, complete the circuit diagram by adding a photodiode.

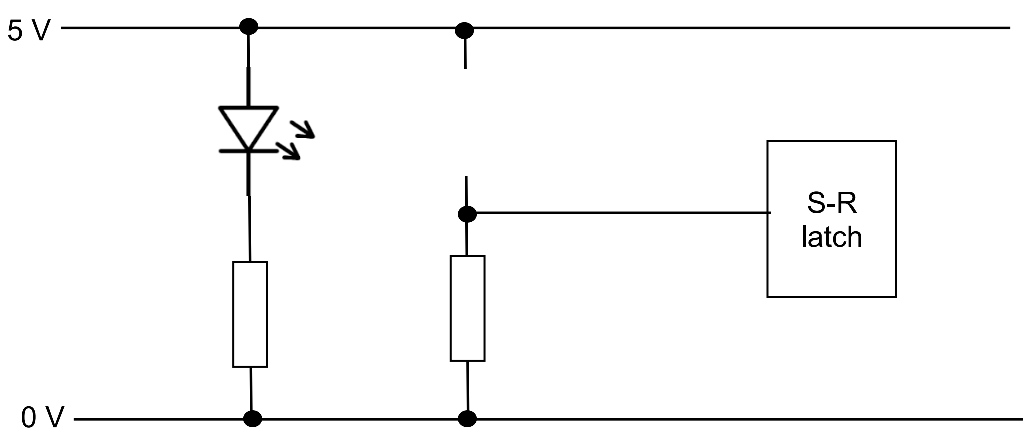


Fig. 13.3

[2]

(b) Each sensing subsystem produces a momentary logic '1' when the car passes between each IR diode and photodiode.
An S-R latch is used to start and stop the CLK circuit.
Table 13.1 shows the truth table for the function of the S-R latch.

Table 13.1

Sensor 1	**Sensor 2**	**S-R latch**				**Input to CLK**
		S	**R**	**Q**	**$\overline{Q}$**	
0	0	0	0	0	1	0
1	0	1	0	1	0	1
0	0	1	0	1	0	1
0	1	0	1	0	1	0
1	1	0	0	0	1	0

Complete Fig. 13.4 with an S-R latch, using logic gates that provide the function shown in Table 13.1.

[4]

Fig. 13.4

(c) Fig. 13.5 shows the pin connection diagram for a 74LS390 IC 4-bit decade counter.

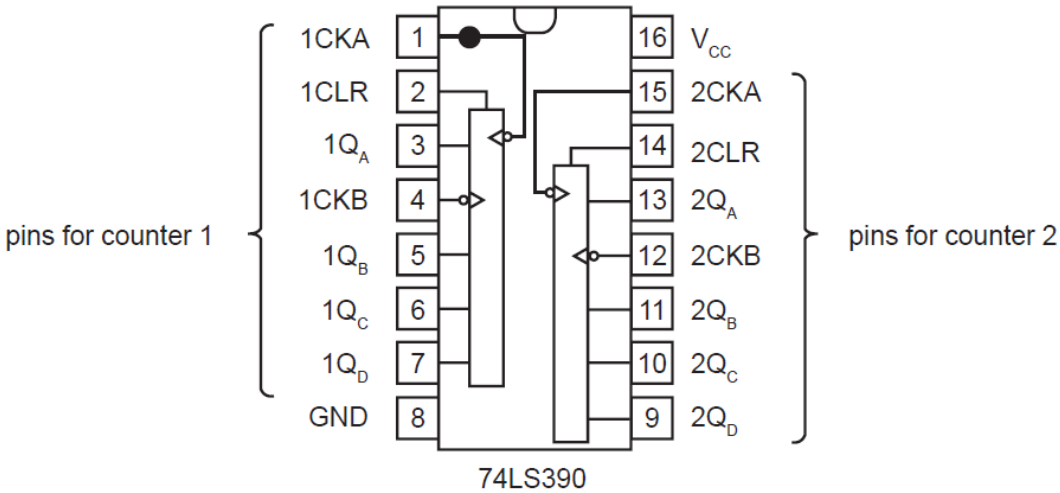


Fig. 13.5

(i) Explain what does the symbol " " in 74LS390 represent?

.... [1]

(ii) Complete Fig. 13.6 with the following connections by referencing to Fig. 13.5:
- 100Hz CLK signal to clock A, counter 1input of the 74LS390
- Connections to the 7-segment display modules to allow the circuit to count up to 99
- A connection from the 74LS390 to the supply rails
- A reset that will clear both displays.

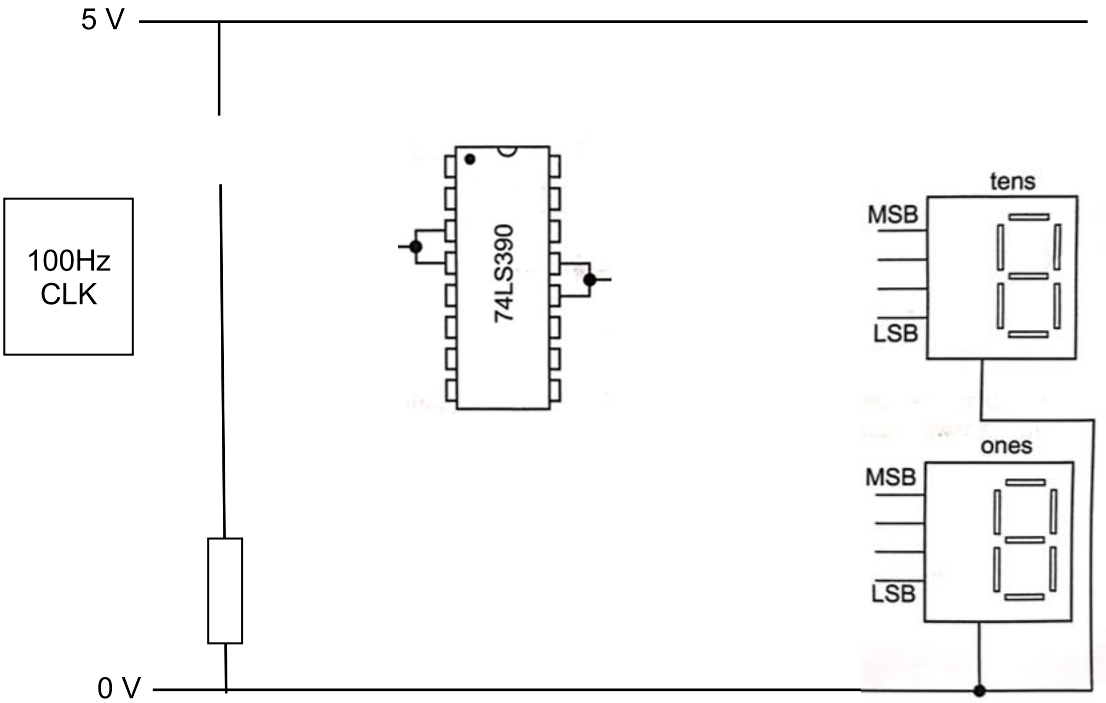


Fig. 13.6

[6]

(d) The CLK signal has an output of 100 Hz.
Explain what is meant by 100 Hz.

……

…… [2]

END OF PAPER

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