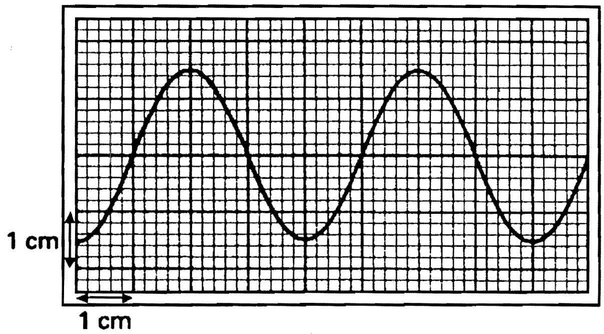
TOPIC 23 Introductory Electronics

23.1 Use of cathode-ray oscilloscope

1 The diagram shows a trace on an oscilloscope set at 10 volts per cm on the vertical axis.

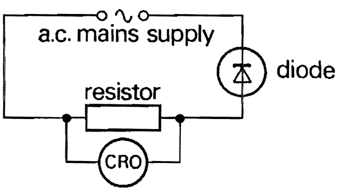


What is the maximum value of the potential difference being measured?

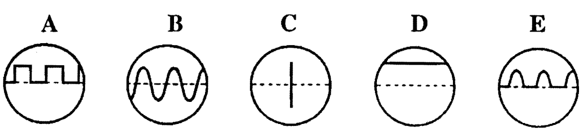
A 1.5 V **B** 3.0 V **C** 7.5 V **D** 15 V **E** 30 V

J91/I/36

2 The diagram shows a circuit which includes a suitably adjusted cathode-ray oscilloscope (CRO) with its time base switched on.

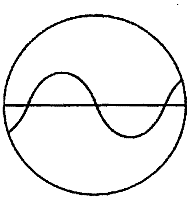


Which trace would appear on the screen of the cathode-ray oscilloscope?



J92/I/36

3 The diagram shows the trace on the screen of a cathode-ray oscilloscope, with the time-base adjusted.

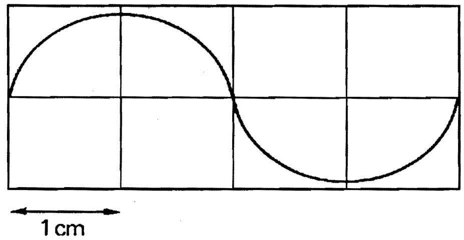


This trace was produced by an alternating voltage applied to

A the anode.
B the cathode.
C the fluorescent screen.
D the heater.
E the Y-plates.

N92/I/35

4 The time-base of cathode-ray oscilloscope is set to 100 ms/cm.

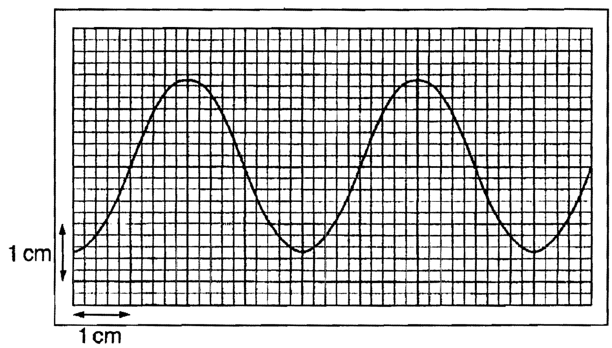


What is the time for one complete cycle of the signal?

A 0.1 s
B 0.2 s
C 0.4 s
D 0.8 s
E 1.6 s

N92/I/36

5 The diagram shows a trace on an oscilloscope set at 5 V/cm on the vertical axis.

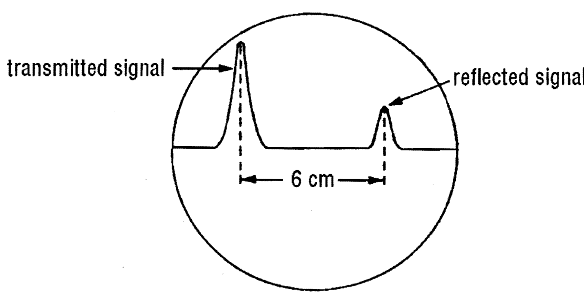


What is the maximum value of the potential difference being measured?

A 1.5 V
B 3.0 V
C 7.5 V
D 15 V

J95/I/35

6 Sonar waves are emitted from a surface vessel which is determining the depth of the sea. The emitted signal and its reflection from the sea bed are displayed on the screen of a cathode ray oscilloscope as shown below.



Given that the speed of sound in water is 1 200 m/s and that the horizontal speed of the oscilloscope trace is 8 cm/s, calculate the depth of the sea at this point.

J85/I/10

7 *(b)* In order to produce the trace shown in Fig. 1, the voltage sensitivity of an oscilloscope was set at 0.50 V per division and the time-base was set at 2.0 ms per division.

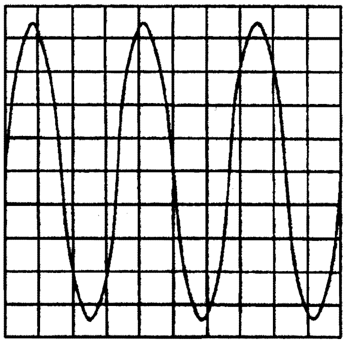


Fig. 1

For the voltage applied to the Y-terminals, determine

(i) the peak value,

(ii) the period,

(iii) the frequency. [3]

N91/II/11*(b)*

8 Figure 2 illustrates the trace obtained on the screen of an oscilloscope when a given signal is applied to the input terminals. The voltage sensitivity is 0.20 V/cm and the time-base is set to 2.0 ms/cm.

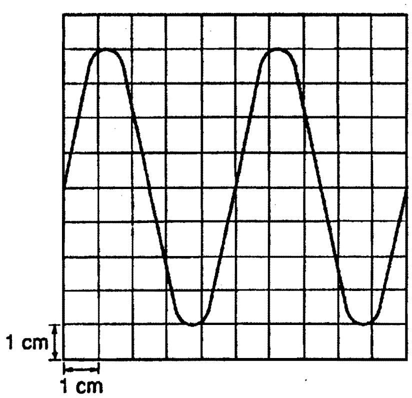


Fig. 2

(a) Determine the maximum positive value of the voltage indicated. [2]

(b) Determine the frequency of the signal. [2]

N93/II/8

9 Fig. 3 shows the oscilloscope trace obtained when a pulse of ultrasound is reflected from a distant object. The larger peak shows the transmitted pulse; the smaller peak shows the reflected pulse. The oscilloscope has a voltage setting of 6.0 mV/cm and a time-base setting of 0.20 ms/cm.

Determine the voltage of each pulse and the time interval between them.

transmitted pulse voltage = ...

reflected pulse voltage = ...

time interval = ... [3]

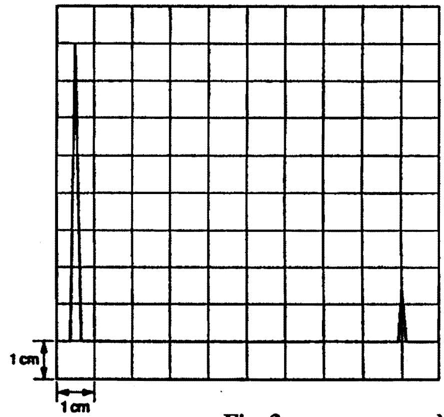


Fig. 3 N97/II/8

10 *(c)* Fig. 4 shows a trace obtained on an oscilloscope screen.

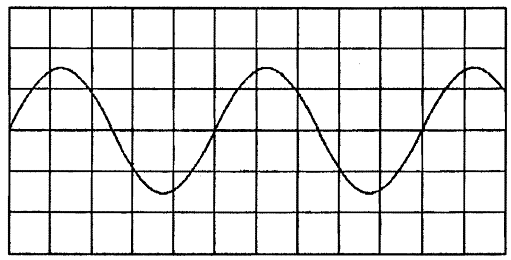


Fig. 4

The time-base is set at 10 ms/cm.

(i) Determine the time for one complete oscillation on the screen.

(ii) Calculate the frequency of the signal applied to the oscilloscope.

(iii) With the same signal applied to the oscilloscope, the time-base setting is altered to 20 ms/cm. State what effect this has on the trace shown on the screen. [5]

J2000/II/10*(c)*

23.2 Action & use of circuit components

1 Which of the following statements applies to a thermistor?

A Its resistance rises when more light falls on it.

B Its resistance drops when more light falls on it.

C Its resistance rises when its temperature increases.

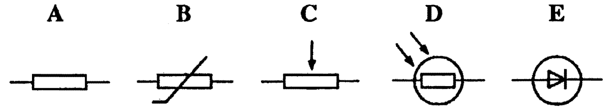
D Its resistance does not change when its temperature increases.

E Its resistance drops when its temperature increases.

J90/I/35

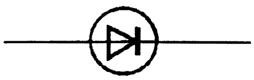
2 What symbol is used for a light-dependent resistor?

A **B** **C** **D** **E**



J91/I/35

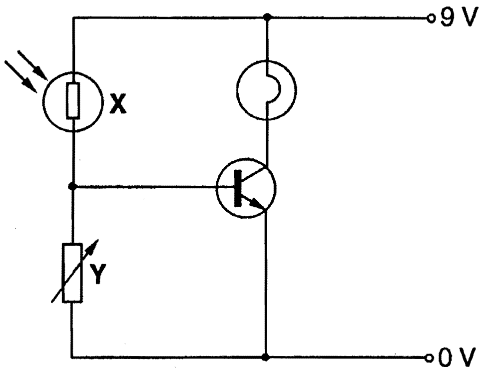
3 The diagram shows the circuit symbol for an electrical component.



What does this symbol represent?

A a bell
B a diode
C a fuse
D a magnetising coil
E a relay N92/I/28

4 The diagram shows a circuit.

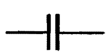


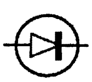
What are components **X** and **Y**?

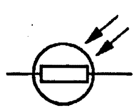
	X	Y
A	lamp	resistor
B	lamp	variable resistor
C	light-dependent resistor	resistor
D	light-dependent resistor	variable resistor
E	resistor	thermistor

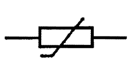
J93/I/36

5 Which component can be used as a temperature sensor in an electric circuit?

A capacitor 

B diode 

C light-dependent resistor 

D thermistor 

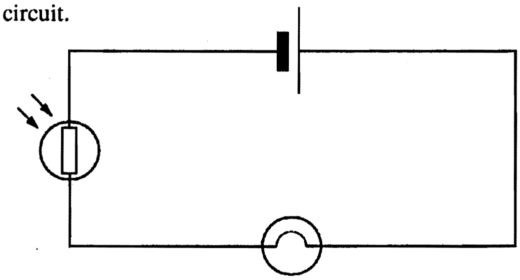
N94/I/36

6 How does the resistance of a thermistor and the resistance of a light-dependent resistor change when their surroundings become hotter and darker?

	resistance of thermistor as it gets hotter	*resistance of light-dependent resistor as it gets darker*
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

N96/I/36

7 The diagram shows a light-dependent resistor (LDR) in a circuit.



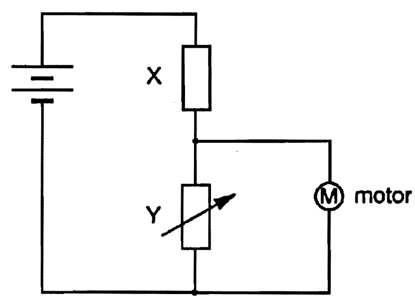
What could this circuit be used for?

A to switch on the lamp when daylight begins
B to switch on the lamp when it begins to get dark
C to make the battery charge up in sunlight
D to make the lamp flash on and off N97/I/36

8 Why is a thermistor useful as an input transducer?

A Its resistance decreases as the light on it increases.
B Its resistance decreases as its temperature increases.
C Its resistance increases as the light on it increases.
D Its resistance increases as its temperature increases.
J98/I/34

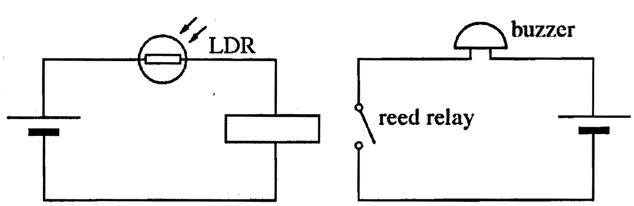
9 In the circuit, resistors X and Y act as a potential divider used to control the speed of a motor.



What is the reason for the potential divider?

A to vary the current through X
B to vary the e.m.f. of the battery
C to vary the potential difference across the motor
D to vary the resistance of the motor N98/I/34

10 The diagram shows a light-sensitive alarm which uses a light-dependent resistor (LDR), a reed relay and a buzzer.

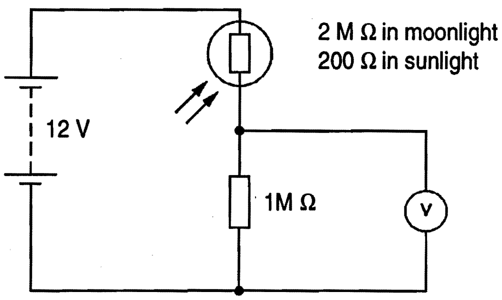


Which of the following describes the resistance of the LDR, the position of the reed relay switch and the condition of the buzzer when light is shining?

	resistance of LDR	reed relay switch	buzzer
A	high	closed	off
B	high	open	on
C	low	closed	on
D	low	open	off

J99/I/34

11 A circuit with a light-dependent resistor is used to detect changes in light levels.



What are the approximate voltmeter readings in moonlight and in sunlight?

	reading in moonlight/V	reading in sunlight/V
A	4	0
B	4	12
C	8	0
D	8	4

N2000/I/35

12 In the circuit shown in Fig. 15, **E** is a battery of e.m.f. 1.50 V and negligible internal resistance, **R** is a resistor or resistance 1.20 kΩ and **T** is a thermistor.

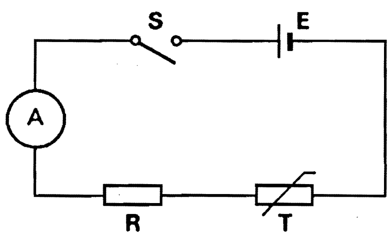


Fig. 5

(a) Explain what is meant by

(i) an e.m.f of 1.50 V,

(ii) a thermistor. [2]

(b) When switch **S** is closed, the current in the circuit is 0.500 mA. Calculate

(i) the resistance of the whole circuit,

(ii) the resistance of the thermistor,

(iii) the potential difference across the thermistor,

(iv) the power developed in the thermistor. [6]

(c) The resistance of the thermistor is known to be about 3000 Ω at 0 °C. In an experiment you have to determine this resistance as accurately as possible.

(i) Describe with the aid of a labelled diagram how you would keep the temperature of the thermistor constant at 0 °C.

(ii) Draw a diagram of the circuit you would use to determine the resistance. State the e.m.f. of the battery you would use and the full scale deflections of any meters in the circuit. [7]

J90/II/12

13 In the circuit shown in Fig. 6.1 **E** is a battery of e.m.f. 6.0 V and negligible internal resistance. $\mathbf{R_1}$ and $\mathbf{R_2}$ are resistors, each of resistance 150 Ω, $\mathbf{V_1}$ is a high resistance voltmeter and **A** is an ammeter of negligible resistance.

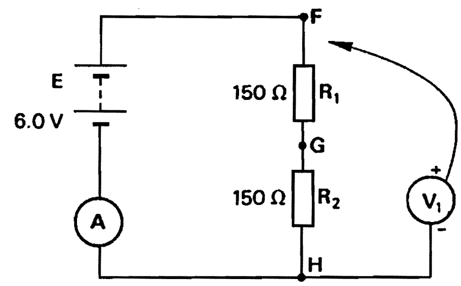


Fig. 6.1

(a) (i) What are the ammeter and voltmeter readings when the positive terminal of the voltmeter is connected to point **F**?

(ii) What are the corresponding ammeter and voltmeter readings when the positive terminal of the voltmeter is connected to first to point **G** and then to point **H**? [4]

(b) The circuit is now changed by connecting a light–dependent resistor (LDR) in series with a resistor of resistance 1200 Ω as shown in Fig. 6.2. $\mathbf{V_2}$ is a second high resistance voltmeter.

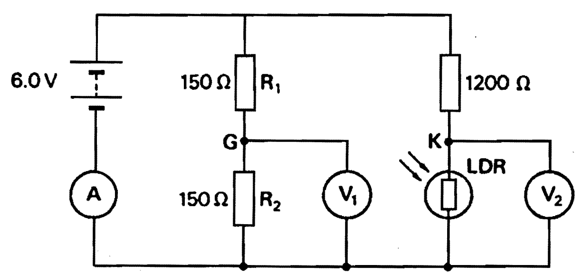


Fig. 6.2

When no light falls on the LDR, its resistance is 3600 Ω. When the only light falling on the LDR comes from a small filament lamp placed 50 mm away, its resistance is 1200 Ω.

(i) Calculate the readings on **A** and $\mathbf{V_2}$ when no light falls on the LDR.

(ii) Calculate the reading on V_2 when light from the lamp falls on the LDR.

(iii) Calculate the reading on a suitable high resistance voltmeter connected to points **G** and **K** when light from the lamp falls on the LDR. [6]

(c) **EITHER**

It is decided to investigate how the voltage across the LDR changes as the intensity of the light falling on the LDR is varied.

(i) With the aid of a labelled diagram, describe how you would arrange the LDR and the lamp so that all other light is excluded and so that the distance between the LDR and the lamp can be varied and measured. Fig. 6.3 shows the LDR and the lamp.

(ii) Describe briefly how you would obtain a set of values for the distance between the lamp and the LDR and the corresponding voltages across the LDR. [5]

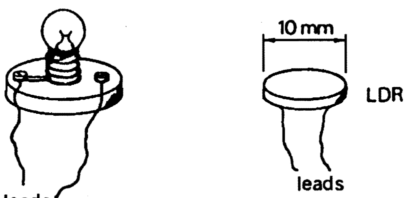


Fig. 6.3

*** OR**

(i) Draw a circuit diagram showing how you would use the circuit shown in Fig. 6.2 together with a transistor so that a lamp is switched on only when the intensity of the light falling on the LDR falls below a certain value.

You need not calculate component values.

(ii) Explain briefly how the circuit works. [5]

N90/II/11

14

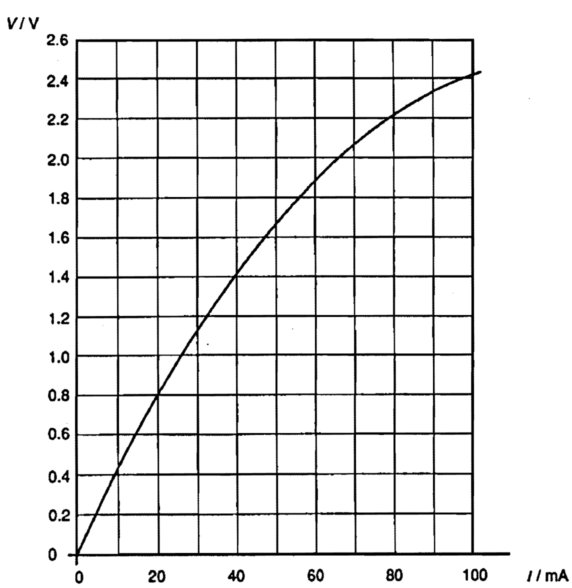


Fig. 7

A thermistor is connected to a variable voltage d.c. supply. The voltage V across and the current I through the thermistor are measured as the voltage is increased. At each stage, the temperature of the thermistor is allowed to reach a steady value before the meter readings are recorded. Figure 7 shows the resulting variation of voltage with current.

Determine, for a voltage across the thermistor of 2.00 V,

(a) the value of the current,

(b) the thermistor resistance,

(c) the power developed in the thermistor. [6]

J94/II/8

15 *(b)* The 8.0 Ω resistor is replaced by a thermistor, **T**, as shown in Fig. 8.1.

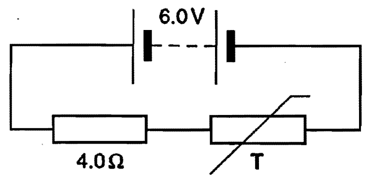


Fig. 8.1

Fig. 8.2 shows how the resistance R of the thermistor varies with temperature θ.

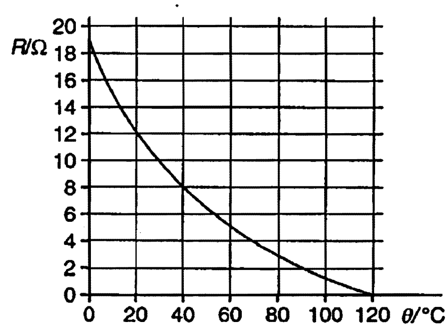


Fig. 8.2

(i) Describe in words the way in which the resistance of the thermistor varies with temperature.

(ii) Determine the resistance of the thermistor when its temperature is 0 °C and when its temperature is 100 °C.

(iii) Determine the maximum power and minimum power developed in the 4.0 Ω resistor when the temperature of the thermistor is allowed to vary between 0 °C and 100 °C. [7]

J96/II/10*(b)*

16 In the circuit shown in Fig. 9, a 4700 Ω resistor is connected in series with a light-dependent resistor (LDR), which has a resistance of 3300 Ω, and with a 12 V power supply.

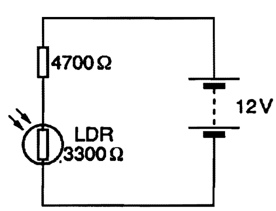


Fig. 9

(*a*) Calculate the current through the LDR.

current = ... [2]

(*b*) Calculate the voltage across the LDR.

voltage = ... [1]

(*c*) The resistance of the LDR decreases as brighter light falls on it.

Describe and explain how the voltage across the LDR changes as the brightness of the light that falls on it increases. [3]

N98/II/7

17 (*a*) The circuit shown in Fig. 10 acts as a light sensitive switch.

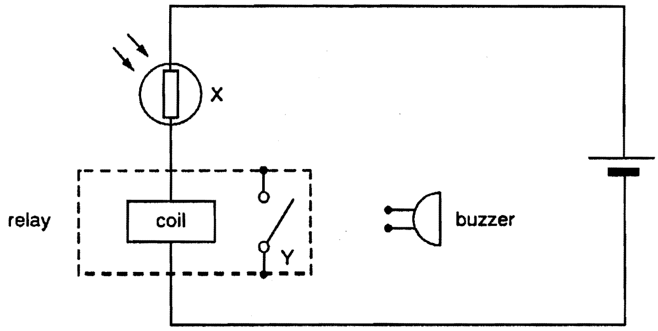


Fig. 10

The component X is a light dependent resistor (LDR). The connections to the buzzer and to the switch Y inside the relay have not been drawn. Switch Y is shown open in Fig. 10.

(i) On Fig. 10, draw the connections to the buzzer, the switch Y and the cell that will allow the buzzer to sound when the switch Y inside the relay closes.

(ii) Complete the table below stating

1. whether the resistance of the LDR is **high** or **low** in the light and in the dark,
2. whether the current through the relay coil is **high** or **low** in the light and in the dark.

	resistance of LDR	current through relay coil	relay switch Y	buzzer
light			closed	ON
dark			open	OFF

[4]

N99/II/4

23.3 Logic gates and combinations

1 Fig. 11 shows a system of logic gates which has a number of different uses.

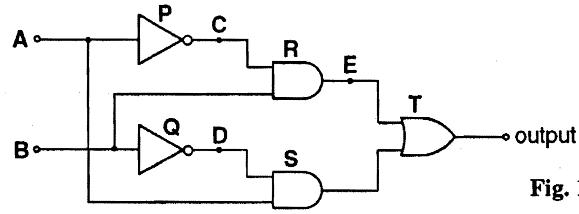


Fig. 11

(*a*) The logic gates have been labelled **P, Q, R, S** and **T.** Which, if any, of the gates are

(i) AND gates,

(ii) NOT gates,

(iii) OR gates? [3]

(*b*) Copy and complete the following truth tables for the logic states at points **C, D** and **E.**

A	C

B	D

C	B	E

(*c*) The truth table for the whole system is shown below.

B	A	*output*
0	0	0
0	1	1
1	0	1
1	1	0

State and explain how this truth table differs from the truth table for an OR gate. [2]

J90/II/12 (part)

2 (*c*) Fig. 12 is a diagram of a logic circuit; inputs **A** and **B** are at logic 0 when not connected.

Initially the output **Q** is at logic 1.

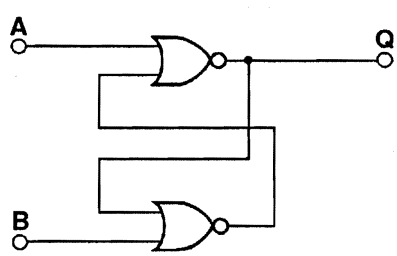


Fig. 12

(i) Name the logic gates used in the circuit.

(ii) This is special type of logic circuit. What is it called?

(iii) Explain the changes in the logic state of output **Q** when, first, input **A** is put at logic 1 for a short time, and then, second, input **B** is put at logic 1 for a short time. [5]

N92/II/11*(c)*

3 *(c)* Write out truth tables for

(i) an AND gate,

(ii) an OR gate,

(iii) a NAND gate. [3]

(d) Each of the circuits shown in Fig. 13.1 and in Fig. 13.2 forms a logic gate.

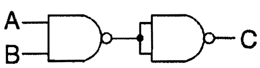


Fig. 13.1

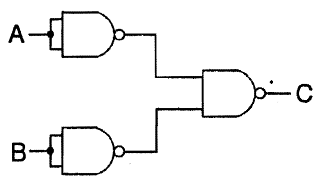


Fig. 13.2

What type of logic gate is formed by the circuit shown in

(i) Fig. 13.1,

(ii) Fig. 13.2? [2]

N95/II/11*(c, d)*

4 *(b)* (i) State the names of the logic gates shown in Fig. 14.

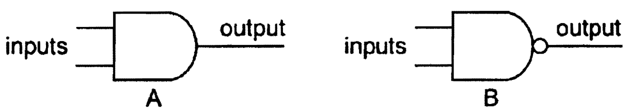


Fig. 14

logic gate A .... logic gate B ....

(ii) Describe the difference in the action of the two logic gates when HIGH (1) and LOW (0) signals are applied to their inputs. [4]

N99/II/4*(b)*

ANSWERS

23.1 Use of cathode-ray oscilloscope

1. **D** 2. **E** 3. **E** 4. **C** 5. **C**

6. 450 m

7. *(b)* (i) 2.25 V (ii) 6.67 m/s (iii) 150 Hz

8. *(a)* 0.8 V *(b)* 100 Hz

9. 48 mV ; 9 mV ; 1.70 ms

10. *(c)* (i) 50 ms (ii) 20 Hz

23.2 Action and use of circuit components

1. **E** 2. **D** 3. **B** 4. **D** 5. **D**

6. **B** 7. **A** 8. **B** 9. **C** 10. **C**

11. **B**

12. *(b)* (i) 3000 Ω; (ii) 1800 Ω; (iii) 0.9 V; (iv) 0.45 mW

13. *(a)* (i) 0.02 A; 6V
(b) (i) 0.0213 A; 4.5 V
(ii) 3 V
(iii) 0

14. *(a)* 0.066 A; *(b)* 30.3 Ω; *(c)* 132 mW

15. *(b)* (ii) 19 Ω; 1.5 Ω (iii) 4.8 W; 0.27 W

16. *(a)* 1.5 mA; *(b)* 4.95 V

17. *(a)* (ii)

	resistance of LDR	current through relay coil	relay switch Y	buzzer
light	low	high	closed	ON
dark	high	low	open	OFF

23.3 Logic gates and combinations

2. *(c)* (i) NOR gate (ii) Bistable circuit

4. A – AND
B – NAND