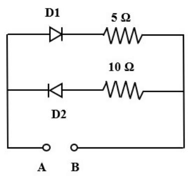
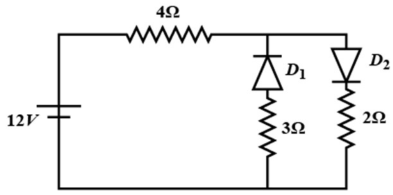
SEMICONDUCTOR DEVICES

PHYSICS

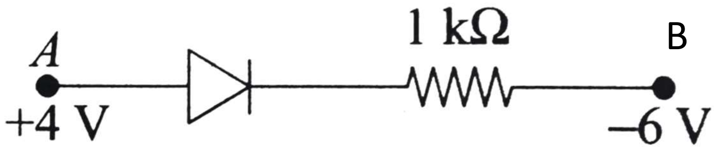
1. The electrical conductivity of a semi-conductor increases when electromagnetic radiation of wave length shorter than 2480 nm is incident on it. The band gap in (eV) for the semi- conductor is
   1) 0.5 eV 2) 0.7 eV 3) 1.1 eV 4) 2.5 eV
2. A 2v battery is connected across AB as shown in the figure. The value of current supplied by the battery when in one case battery positive terminal is connected A and in other case when positive terminal of battery is connected to B will respectively be
   1) 0.2 A and 0.1 A 2) 0.4 A and 0.2 A 3) 0.1 A and 0.2 A 4) 0.2 A and 0.4 A



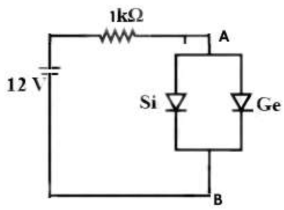
3. For a transistor amplifier in common emitter configuration for load impedance of 1kΩ (h_{fe}=50 and h_{oe}=25) the current gain is
   1) -5.2 2) -15.7 3) -24.8 4) -48.78
4. In the ratio of the concentration of electrons that of holes in a semi- conductor is 7/5 and the ratio of currents is 7/4 then what is the ratio of their drift velocities
   1) 4/7 2) 5/8 3) 4/5 4) 5/4
5. The circuit has two oppositely connect ideal diodes in parallel what is the current flowing in the circuit
   1) 1.33 A 2) 1.71 A 3) 2 A 4) 2.31 A



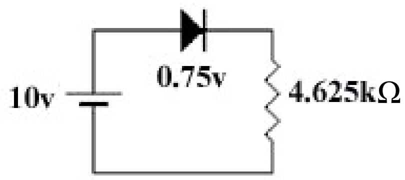
6. A pure semi-conductor has equal electron and hole concentration of $10^{16}/m^3$. Doping by indium increases n_h to $4.5x10^{22}$ m^3. What is n_e in the doped semi-conductor
   1) $10^6/m^3$ 2) $10^{22}/m^3$ 3) $\frac{10^{32}}{4.5\times10^{22}}/m^3$ 4) $4.5\times10^{22}/m^3$
7. The current gain β of a transistor is 50. The input resistance of the transistor, when used in the common emitter configuration is 1kΩ. The peak value of the collector a.c current for an alternating peak input voltage 0.01 v is
   1) 100 μA 2) 250 μA 3) 500μA 4) 800 μA
8. A common emitter amplifier is designed with npn transistor (α=0.99). The input impedance is 1kΩ and load is 10kΩ. The voltage gain will be
   1) 9.9 2) 99 3) 990 4) 9900
9. Consider the junction diode as ideal. The value of current flowing through AB is
   1) 10^{-3}A 2) 0 A 3) 10^{-2}A 4) 10^{-1}A



10. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain with out feedback will be
1) 100 2) 90 3) 10 4) 1.25
11. In an intrinsic semi-conductor, the number of conduction electrons is 2.5×10^{18} in one cubic metre. The total number of current carriers in the same semi-conductor of size 1cm x 1cm x 1cm is
1) 5×10^{18} 2) 5×10^{12} 3) 2.5×10^{18} 4) 7.5×10^{12}
12. A circuit containing diodes is shown in the figure. The potential difference across point A and B (V_A-V_B) is
1) 11.7 v 2) 11.3 v 3) 0.7 v 4) 0.3 v

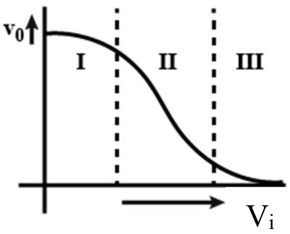


13. In the circuit, if the forward voltage drop for the diode is 0.75v, the current will be
1) 4mA 2) 3mA 3) 2mA 4) 8mA

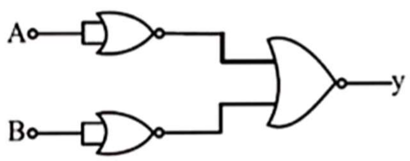


14. In a full wave rectifier if output frequency is 50 HZ then input frequency applied would have been
1) 25 HZ 2) 20 HZ 3) 50 HZ 4) 100 HZ
15. Two CE amplifiers are connected in series. The voltage gains of amplifiers are 10 and 45 respectively. If at the input of transistor a signal of 2mv is applied then the signal output on the collector of other amplifier (right most) will be
1) 450v 2) 900v 3) 45v 4) 0.9v
16. An LED is constructed from a p-n junction diode using GaAsp. The energy gap is 1.9 ev. The wave length of light emitted will be equal to
1) 10.4×10^{-26}m 2) 654 nm 3) 654 A^0 4) 654×10^{-11}m
17. A p-n photo diode is made of a material with a band gap of 2.0 ev. The minimum frequency of the radiation that can be absorbed by the material is nearly
1) 1×10^{14} HZ 2) 20×10^{14} HZ 3) 10×10^{14} HZ 4) 5×10^{14} HZ
18. For CE transistor amplifier, the audio signal voltage across the collector resistance of 2kΩ is 4v. if the current amplification factor of the transistor is 100 and the base resistance is 1kΩ, then the input signal voltage is
1) 10 mv 2) 20 mv 3) 30 mv 4) 15 mv
19. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω. The power gain of the amplifier is
1) 500 2) 1000 3) 1250 4) 50
20. Transistor characteristics [output voltage (V_o) versus input voltage (V_i)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used

1) In region III
2) both in region (I) and (III)
3) In region II
4) In region I

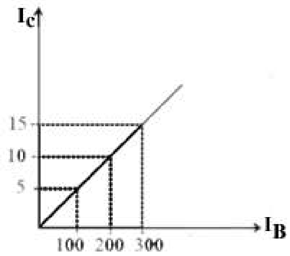


21. Identify the logic operation performed by the given circuit



1) AND gate
2) OR gate
3) NOR gate
4) NAND gate

22. In an experiment of CE configuration of n-p-n transistor, the transfer characteristics, are observed as given in figure. If the input resistance is 200Ω and output resistance is 60Ω the voltage gain in the experiment is

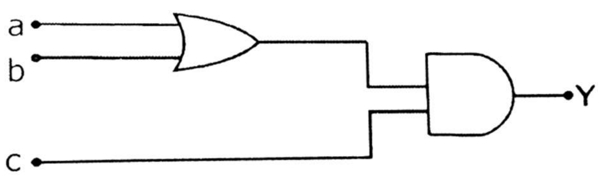


1) 10
2) 15
3) 20
4) 30

23. A transistor is used in an amplifier circuit in common emitter mode. If the base current changes by 100mA, it brings a change of 10mA in collector current. If the load resistance is 2kΩ and input resistance is 1kΩ, the value of power gain is $X \times 10^4$. The value of x is
1) 3
2) 4
3) 2
4) 1

24. A potential barrier of 0.4 V exists across a p-n junction. An electron enters the junction from n-side with a speed 6.0×10^5 ms^{-1}. The speed with which electron enters the p-side will be $\frac{x}{3} \times 10^5$ ms^{-1}. The value of x is
1) 10
2) 12
3) 14
4) 16

25. To get an output of 1 from the circuit shown in figure the input must be



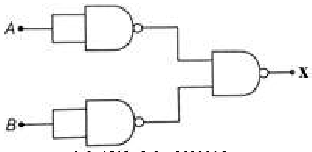
1) a=0, b=0, c=1
2) a=1, b=0, c=0
3) a=1, b=0, c=1
4) a=0, b=1, c=0

26. Given truth table is for which gate
1) AND
2) OR
3) NOR
4) NAND

A	B	C

1	1	1
1	0	0
0	1	0
0	0	0

27. The combination of gates shown in figure.

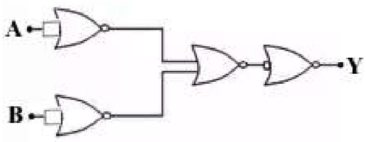


1) OR gate 2) NOT gate 3) XOR gate 4) NAND gate

28. For a common emitter configuration, it α and β have their usual meanings , the incorrect relation between α and β is

1) $\alpha = \frac{\beta^2}{1+\beta^2}$ 2) $\frac{1}{\alpha} = \frac{1}{\beta} + 1$ 3) $\beta = \alpha(1+\beta)$ 4) $\alpha = \frac{\beta}{1+\beta}$

29. Identify the gate



1) AND 2) XOR 3) NOR 4) NAND

30. According to de Morgan's theorem

1) $\overline{A+B+C} = \overline{A}+\overline{B}+\overline{C}$ 2) $\overline{ABC} = \overline{ABC}$

3) $\overline{ABC} = \overline{A}+\overline{B}+\overline{C}$ 4) $\overline{A+B+C} = ABC$

KEY

	1	2	3	4	5	6	7	8	9	10
	PHYSICS									
01-10	1	2	4	4	3	**3**	3	3	3	1
11-20	2	**4**	3	**1**	**4**	2	4	2	3	**2**
21-30	1	2	3	3	3	1	1	1	4	3

SEMICONDUCTOR DEVICES

HINTS & SOLUTIONS

PHYSICS

1. Band gap = Energy of photon of λ=2480 nm

Energy gap = $\frac{hc}{\lambda} J = \frac{hc}{\lambda e} eV$

$$\therefore Band\,gap = \frac{6.63\times10^{-34}\times3\times10^{8}}{2480\times10^{-9}\times1.6\times10^{-19}}$$

$=0.5$ eV

2. When positive terminal of battery is connected to A, current passes through diode D_1

$\therefore$ current supplied $= \dfrac{2V}{5\Omega} = 0.4A$

When positive terminal is connected to B, current passes through D_2

$\therefore$ current supplied $= = \dfrac{2V}{10\Omega} = 0.2A$

3. Current gain,

$$A_i = \frac{-h_{fe}}{1+(h_{oe})R_L}$$

$$= \frac{-50}{1+(25\times10^{-6})\times\left(1x10^{3}\right)}$$

$$= \frac{-50}{1+0.025} = -48.78$$

4. Drift velocity $V_d = \dfrac{I}{nAe}$

$$\frac{(V_d)_{electron}}{(V_d)_{hole}} = \left(\frac{I_e}{I_h}\right)\left(\frac{n_h}{n_e}\right)$$

$$= \frac{7}{4}\times\frac{5}{7} = \frac{5}{4}$$

5. Since diode D_1 is reverse biased, it will act like an open circuit.

Effective resistance R=4+2=6Ω

Current in the circuit is $I = \dfrac{E}{R} = \dfrac{12}{6} = 2A$

6. $n_e n_h = n^2$

$$n_e = \tfrac{n^2}{n_h} = \frac{10^{16}\times10^{16}}{4.5\times10^{22}}$$

$$= \frac{10^{32}}{4.5\times10^{22}} / m^3$$

7. $\beta = \dfrac{i_C}{i_b} = 50$

$$\frac{R_i i_c}{v_i} = 50$$

$$i_c = \frac{50\times0.1}{10^3} = 500\mu A$$

8. $\alpha = 0.99$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$$

$$R_i = 1k\Omega, R_L = 10k\Omega$$

$$A_v = \beta\left[\frac{R_L}{R_i}\right] = \frac{99\times10\times10^3}{1\times10^3} = 990$$

9. $V_A - V_B = IR$

$$4-(-6) = I\times1k\Omega$$

$$I = \frac{10}{10^3} = 10^{-2}A$$

10. $A_{fb} = \frac{A}{1-mA}$

$m = \frac{A}{1+\frac{9A}{100}}$

$10 + \frac{9}{10}A = A$

$\therefore$A=100

11. $n_e = n_h (for\ \text{int}\ rinsic\ semiconductor)$

$n_e = 2.5\times10^{18}\ m^{-3} = n_h$

$\therefore n_e + n_h = 2\times2.5\times10^{18}$

$= 5\times10^{18}\ m^{-3}$

$n^1 = 5\times10^{18}\times10^{-6} = 5\times10^{12}$

12. Knee voltage for Si is 0.7 V while for Ge is 0.3 V. Hence only Ge diode will be on and hence

$V_A - V_B = 0.3V$

13. $i = \frac{V-V_d}{R} = \frac{10-0.75}{4.625\times10^3}$

$= \frac{9.25\times10^{-3}}{4.625} = 2mA$

14. For full wave rectifier, output frequency=input frequency x2

$\therefore$ Input frequency $= \frac{output\ frequency}{2}$

$= \frac{50}{2} = 25Hz$

15. $A=A_1A_2$

$= 10\times45 = 450$

$V_O=AV_i$

$=450\text{x}2\text{x}10^{-3}=0.9$ V

16. Energy gap=1.9 Ev

wave length of light emitted,

$\lambda = \frac{1242eV.nm}{1.9eV}$

=654nm

17. Band gap=2 eV

$\lambda = \frac{hc}{E} = \frac{12400\,eV\ A^0}{2\,eV}$

=6200 A^0

Frequency $\nu = \frac{C}{\lambda}$

$= \frac{3\times10^8}{6200\times10^{-10}}$

$=5\text{x}10^{14}$ HZ

18. Voltage gain $A = \beta\frac{R_C}{R_B}$

$= 100\times\frac{2000}{1000}$

=200

$A = \frac{V_o}{V_i} \Rightarrow V_i = \frac{V_o}{A} = \frac{4}{200}$

=20 mv

19. Resistance gain $= \frac{R_o}{R_i}$

$= \frac{200}{100} = 2$

Power gain $= \frac{(voltage\, gain)^2}{\text{Re}\, sis \tan ce\, gain}$

$= \frac{50 \times 50}{2} = 1250$

20. In the given graph,

Region (I) – cut off region

Region (II) – active region

Region (III) – saturation region

Transistor as a switch, it is used in cut off (or) saturation region

Transistor as an amplifier, it is used in active region,

21. $y = \left(\overline{A + A}\right) + \left(\overline{B + B}\right)$

$= \overline{\overline{A} + \overline{B}}$ (D-Morgan law)

Y=AB

AND gate

22. Voltage gain $= \frac{I_C}{I_B} \times \frac{R_o}{R_i}$

$= \frac{10 \times 10^{-3}}{200 \times 10^{-6}} \times \frac{60}{200}$

=15

23. Power $= \beta^2 \times \frac{R_o}{R_i}$

$= \left(\frac{10}{0.1}\right)^2 \times \frac{2}{1}$

$x \times 10^4 = 2 \times 10^4$

$\therefore x = 2$

24. Work energy theorem,

$w = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$-1.6 \times 10^{-19} \times 0.4 = \frac{1}{2} \times 9 \times 10^{-31}(v^2 - u^2)$

$u^2 - v^2 = \frac{2 \times 0.64 \times 10^{12}}{9}$

$v^2 = \left(36 - \frac{128}{9}\right) \times 10^{10}$

$v = \frac{14}{3} \times 10^5$

$\frac{x}{3} \times 10^5 = \frac{14}{3} \times 10^5$

$\therefore x = 14$

25. Output y=(a+b).c

Y=1 if C=1 and

a=0, b=1 (or)

a=1, b=0

26. AND GATE

27.

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

This is truth table of OR gate.

28. $\alpha = \frac{\beta}{1+\beta}$

29. This is NAND gate

$y = \overline{A.B}$

30. According to de Morgan law,

$\overline{A.B.C} = \overline{A} + \overline{B} + \overline{C}$