CHAPTER 4: SEMICONDUCTOR DEVICES AND APPLICATIONS

Single Correct Choice Type Questions

1. The emitter is most heavily doped.
Hence, the correct answer is (A).

2. Collector current,

$$I_C = 10\text{ mA}$$

$$\alpha = \frac{90}{100} = 0.9$$

$$\alpha = \frac{I_C}{I_E}$$

$$\Rightarrow \text{ Emitter current, } I_E = \frac{I_C}{\alpha}$$

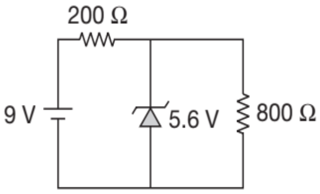
$$I_E = \frac{10}{0.9} = 11\text{ mA}$$

Base current, $I_B = I_E - I_C$

$$I_B = 11 - 10 = 1\text{ mA}$$

Hence, the correct answer is (B).

3.



$$I_{800\,\Omega} = \frac{5.6}{800}\text{ A} = 7\text{ mA}$$

$$I_{200\,\Omega} = \frac{9-5.6}{200} = 17\text{ mA}$$

$$\Rightarrow \quad I_Z = 17 - 7 = 10\text{ mA}$$

Hence, the correct answer is (C).

5. Wave nature of electron and covalent bonds are correlated.
Hence, the correct answer is (A).

7. Copper is conductor and germanium is semiconductor. When cooled, the resistance of copper strip decreases and that of germanium increases.
Hence, the correct answer is (C).

8. Since $I = e^{\frac{1000V}{T}} - 1$

$$\Rightarrow \quad I + 1 = e^{\frac{1000V}{T}}$$

$$\Rightarrow \quad \log_e(I+1) = \frac{1000\text{ V}}{T}$$

$$\Rightarrow \quad d\left[\log_e(I+1)\right] = d\left(\frac{1000\text{ V}}{T}\right)$$

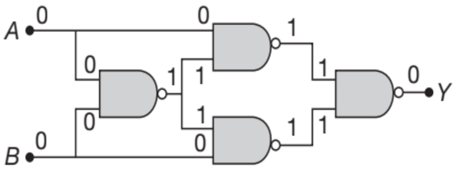
$$\Rightarrow \quad \frac{dI}{I+1} = \left(\frac{1000}{T}\right)dV$$

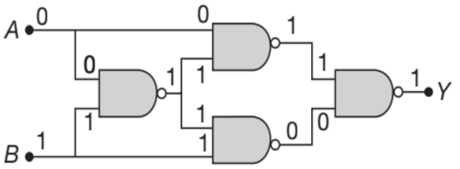
$$\Rightarrow \quad \frac{dI}{(5+1)mA} = \left(\frac{1000}{300}\right)(0.01)$$

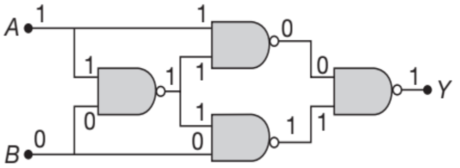
$$\Rightarrow \quad dI = 0.2\text{ mA}$$

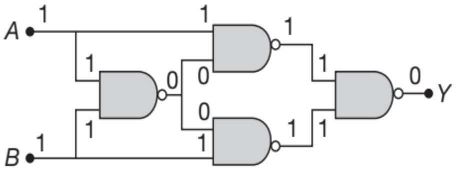
Hence, the correct answer is (A).

9.









Hence, the correct answer is (D).

11. In oscillator, feedback is positive gain with positive feedback

$$A_f = \frac{A}{1-\beta A} > 1$$

Hence, the correct answer is (B).

12. Variation of number of charge carriers with temperature is responsible for variation of resistance in a metal and a semiconductor.

Hence, the correct answer is (B).

13. $i = \dfrac{V_F - V_B}{R}$

$$\Rightarrow \quad R = \frac{V_F - V_B}{i}$$

$$i = \frac{5 - 0.7}{10^{-3}} = 4.3 \times 10^3\ \Omega = 4.3\ \text{k}\Omega$$

Hence, the correct answer is (C).

16. Electric field is zero in the middle of the depletion layer of a reverse biased p-n junction.

Hence, the correct answer is (A).

17. Output of upper OR gate $= W + X$

Output of lower OR gate $= W + Y$

Net output $F = (W + X)(W + Y)$

$$= WW + WY + XW + XY$$

$$= W + WY + XW + XY \quad (\text{since } W.W = W)$$

$$= W(1 + Y) + XW + XY \ (\text{since } 1 + Y = 1)$$

$$= W.1 + XW + XY$$

$$= W(1 + X) + XY = W + XY$$

Hence, the correct answer is (C).

18. $\beta = \dfrac{\alpha}{1 - \alpha} = \dfrac{0.9}{1 - 0.9} = 9$

Hence, the correct answer is (D).

19. $\dfrac{1}{\alpha} - \dfrac{1}{\beta} = \dfrac{1}{(\Delta I_C / \Delta I_E)} - \dfrac{1}{(\Delta I_C / \Delta I_B)}$

$$\frac{1}{\alpha} - \frac{1}{\beta} = \frac{\Delta I_E - \Delta I_B}{\Delta I_C} = \frac{\Delta I_C}{\Delta I_C} = 1$$

Hence, the correct answer is (A).

21. Electrons of n-type emitter move from emitter to base and then base to collector when npn transistor is used as an amplifier

Hence, the correct answer is (A).

25. In common emitter configuration, current gain is

$$A_i = \frac{-(h_{fe})}{1 + (h_{oe})(R_L)} = \frac{-50}{1 + (25 \times 10^{-6}) \times (1 \times 10^3)}$$

$$\Rightarrow \quad A_i = -\frac{50}{1 + 0.025} = \frac{-50}{1.025} = -48.78$$

Hence, the correct answer is (D).

27. Copper is a conductor.

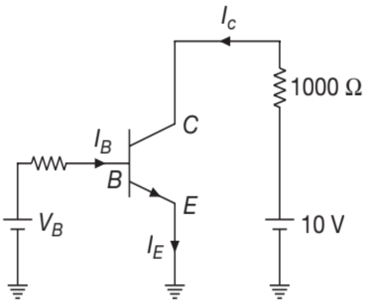
Germanium is a semiconductor.

When cooled, the resistance of copper decreases and that of germanium increases.

Hence, the correct answer is (C).

30. For saturation, $V_{CC} - I_C \times R_C = 0$

$$\Rightarrow \quad I_C = \frac{V_{CC}}{R_C} = \frac{10}{10^3} = 10^{-2}\ \text{A}$$



Since, $\beta = \dfrac{I_C}{I_B} = 250$

$$\Rightarrow \quad I_B = \frac{I_C}{250} = \frac{10^{-2}}{250} = 40\ \mu\text{A}$$

Hence, the correct answer is (D).

32. Pauli's exclusion principle explains band structure of solids.

Hence, the correct answer is (B).

33. $\alpha = \dfrac{I_C}{I_E} = \dfrac{I_E - I_B}{I_E}$

$$\Rightarrow \quad 0.95 = \frac{10 - I_B}{10}$$

$$\Rightarrow \quad I_B = 0.5\ \text{mA}$$

Hence, the correct answer is (B).

34. In circuit 1, I diode is forward biased and II diode is reverse biased; so $R_1 \neq R_2$ hence $V_1 \neq V_2$. In circuit 2, both diodes are forward biased $R_1 = R_2$; so $V_1 = V_2$. In circuit 3, both diodes are reverse biased so $R_1 = R_2$ and hence $V_1 = V_2$

Hence, the correct answer is (B).

36. The energy band gap is maximum in insulators.

Hence, the correct answer is (C).

38. When p-n junction diode is forward biased, both the depletion region and barrier height are reduced.

Hence, the correct answer is (C).

39. $\sigma = n_d e \mu_e$

$$\Rightarrow \quad n_d = \frac{\sigma}{e\mu_e} = \frac{1}{\rho e \mu_e}$$

$$n_d = \frac{1}{0.1 \times 1.6 \times 10^{-19} \times 0.05}$$

$$n_d = 1.25 \times 10^{21}$$

Hence, the correct answer is (C).

41. In a common base amplifier, the phase difference between the input signal and output voltage is zero.
Hence, the correct answer is (A).

42. $i = \dfrac{V_F - V_B}{R} = \dfrac{2-0.7}{20+180} = \dfrac{1.3}{200}$

$$i = 6.5 \times 10^{-3}\ \text{A} = 6.5\ \text{mA}$$

Hence, the correct answer is (C).

43. $A_v = \beta \cdot \dfrac{R_2}{R_1} = 100 \times \dfrac{10 \times 10^3}{1 \times 10^3} = 1000$

Hence, the correct answer is (B).

44. Band gap ΔE_g corresponds to the energy of photon of $\lambda = 2480$ nm

$$\Rightarrow \quad \Delta E_g = \frac{hc}{\lambda}\ \text{J} = \frac{hc}{\lambda e}\ \text{eV}$$

$$\Rightarrow \quad \Delta E_g = \frac{(6.63 \times 10^{-34}) \times (3 \times 10^8)}{(2480 \times 10^{-9}) \times (1.6 \times 10^{-19})}\ \text{eV}$$

$$\Rightarrow \quad \Delta \text{E}_g = 0.5\ \text{eV}$$

Hence, the correct answer is (A).

45. Under forward bias, the width of depletion layer decreases.
Hence, the correct answer is (B).

46. Output of OR gate $= A + B$

Output of NAND gate $= \overline{A \cdot B}$

$\Rightarrow$ Output Y from AND gate $= (A+B) \cdot \overline{AB}$

$$= (A+B) \cdot (\bar{A} + \bar{B}) = A\bar{A} + B\bar{B} + A\bar{B} + B\bar{A}$$

$$= 0 + 0 + A\bar{B} + B\bar{A}$$

This is Boolean expression for XOR gate.

Hence, the correct answer is (B).

47. $\beta = \dfrac{I_C}{I_B} = 200$

$$R_i = \frac{10 \times 10^{-3}}{15 \times 10^{-6}} = 0.67\ \text{k}\Omega$$

So, voltage gain is $A_v = \beta \left(\dfrac{R_o}{R_i} \right) = 300$

Hence, the correct answer is (D).

48. Semiconductor devices are suitable for low voltages.

Hence, the correct answer is (C).

49. $i = \dfrac{\Delta V}{R} = \dfrac{3-1}{100} = 2 \times 10^{-2}\ \text{A} = 20\ \text{mA}$

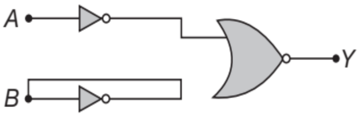
Hence, the correct answer is (C).

50. Frequency of full wave rectifier is

$$f = 2 \times \text{input frequency} = 2 \times 50 = 100\ \text{Hz}$$

Hence, the correct answer is (A).

51.



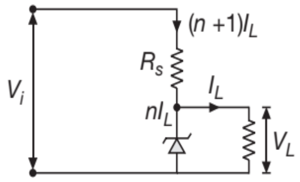
By de Morgan's theorem, $\left(\overline{\bar{A} + \bar{B}}\right) = A \cdot B$

A	**B**	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$	$\overline{\bar{A}+\bar{B}}$	$A \cdot B$
1	1	0	0	0	1	1
0	0	1	1	1	0	0
0	1	1	0	1	0	0
1	0	0	1	1	0	0

This is the same as AND Gate of A and B.

Hence, the correct answer is (A).

53.



Voltage drop across Zener diode is V_L, so voltage drop across R_S is,

$$V_{RS} = V_i - V_L = (n+1) I_L R_S$$

$$\Rightarrow \quad R_S = \frac{V_i - V_L}{(n+1)I_L}$$

Hence, the correct answer is (C).

54. $\dfrac{\text{Reverse resistance}}{\text{Forward resistance}} > 10000$

Hence, the correct answer is (D).

55. Such a solid is formed by covalent bonding.

Hence, the correct answer is (C).

57. $I_C = I_E - I_B = 4\text{ mA} - 40\ \mu\text{A} = (4 - 0.04) = 3.96\text{ mA}$

$$\alpha = \frac{I_C}{I_E} = \frac{3.96}{4} = 0.99$$

Hence, the correct answer is (A).

59. For conductor, ρ increases as temperature rises. For semiconductor, ρ decreases as temperature rises.

Hence, the correct answer is (C).

60. Drift velocity $v_d = \dfrac{I}{neA}$

$$\Rightarrow \quad \frac{(v_d)_{\text{electron}}}{(v_d)_{\text{hole}}} = \left(\frac{I_e}{I_h}\right)\left(\frac{n_h}{n_e}\right) = \frac{7}{4} \times \frac{5}{7} = \frac{5}{4}$$

Hence, the correct answer is (D).

61. $A_f = \dfrac{A}{1 + \beta A}$

$$\Rightarrow \quad 25 = \frac{150}{1 + \beta \times 150}$$

$$\Rightarrow \quad \beta = \frac{1}{30}$$

Hence, the correct answer is (A).

62. Junction diode is reverse biased, so current is zero.

Hence, the correct answer is (A).

65. $\beta = \dfrac{I_C}{I_B} = \dfrac{I_C}{I_E - I_C}$

$$\Rightarrow \quad \beta = \frac{5.488}{5.60 - 5.488} = \frac{5.488}{0.112} = 49$$

Hence, the correct answer is (B).

66. $R = \dfrac{\Delta V}{\Delta i} = \dfrac{2.3 - 0.3}{10 \times 10^{-3}}$

$$R = 0.2 \times 10^3\ \Omega = 0.2\text{ k}\Omega$$

Hence, the correct answer is (B).

68. $Y = \overline{\overline{A} \cdot \overline{B}} = A + B$ (Using De-Morgan's Law)

$\Rightarrow$ OR gate

Hence, the correct answer is (A).

69. Semiconductors, like Si, Ge, act as insulators at low temperature.

Hence, the correct answer is (C).

71. E_c and E_v decrease but E_g increases if the lattice constant of the semiconductor is decreased.

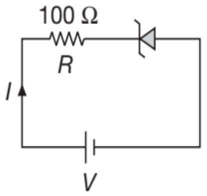
Hence, the correct answer is (D).

73. Potential drop across Zener diode

$$V_Z = V - IR = V - 100I$$

Since, power, $P = V_Z I_Z$

$$\Rightarrow \quad P = (V - 100I)I$$



Given that, $P = 1$ W

$$\Rightarrow \quad (V - 100I)I = 1$$

$$\Rightarrow \quad 100I^2 - VI + 1 = 0$$

For I to be real, $V^2 - 4 \times 100 \times 1 \geq 0$

$$\Rightarrow \quad V \geq 20\text{ V}$$

Hence, the correct answer is (B).

74. A bridge rectifier uses four identical junction diodes.

Hence, the correct answer is (D).

76. $\alpha = \dfrac{\beta}{\beta + 1} = \dfrac{100}{100 + 1} = 0.99$

Hence, the correct answer is (C).

79. $P_{\text{gain}} = \beta^2 \left(\dfrac{R_{\text{out}}}{R_{\text{in}}}\right)$ and $I_{\text{gain}} = \beta$

$$\Rightarrow \quad 10^6 = \beta^2 \left(\frac{10000}{100}\right)$$

$$\Rightarrow \quad \beta = 100$$

Hence, the correct answer is (C).

80. Figure (A) represent a reverse biased diode.

Hence, the correct answer is (A).

81. $\sigma = e(n_e \mu_e + n_h \mu_h)$

In an intrinsic semiconductor

$$n_e = n_h = n_i$$

$$\therefore \quad \sigma = n_i e(\mu_e + \mu_h)$$

$$\Rightarrow \quad n_i = \frac{\sigma}{e(\mu_e + \mu_h)} = \frac{2.13}{1.6 \times 10^{-19}(0.38 + 0.18)}$$

$$\Rightarrow \quad n_i = \frac{2.13 \times 10^{19}}{1.6 \times 0.56} = 2.37 \times 10^{19} \text{ m}^{-3}$$

Hence, the correct answer is (A).

82. $I_B = I_E - I_C = 1 \text{ mA} - 0.95 \text{ mA} = 0.05 \text{ mA}$

Hence, the correct answer is (B).

84. Input current $= \frac{V_i}{R_i} = \frac{0.01}{10^3} \text{A} = 10^{-5} \text{ A}$

$\Rightarrow$ Output collector current

$$i_C = \beta i_B = 50 \times 10^{-5} \text{ A}$$

$$i_C = 500 \ \mu\text{A}$$

Hence, the correct answer is (B).

87. In forward biasing current is due to majority charge carriers which diffuse from higher concentration region to lower concentration region.

In reverse biasing the current is due to minority charge carriers which drift due to applied reverse potential difference.

Hence, the correct answer is (B).

88. $A_v = \beta \times \frac{R_2}{R_1} = 60 \times \frac{24}{3} = 480$

Hence, the correct answer is (D).

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

Effective resistance of the circuit is

$$R = 4 + 2 = 6 \ \Omega$$

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

Hence, the correct answer is (C).

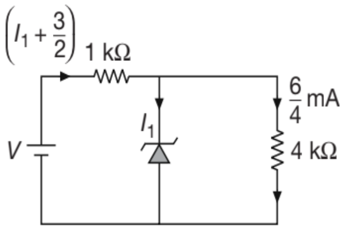
91. Peak value $E_0 = E_{rms}\sqrt{2} = 100\sqrt{2}$

Also $E = \sqrt{E_{\text{diode}}^2 + E_C^2} = E_C$, since $R_F = 0$

$$\Rightarrow \quad (E_C)_{\text{maximum}} = E_0 = 100\sqrt{2} \text{ volt}$$

Hence, the correct answer is (B).

94.



$$I_1 = \left(8 - 6 - \frac{3}{2}\right) = \frac{1}{2} = 0.5 \text{ mA}$$

$$I_2 = \left(16 - 6 - \frac{3}{2}\right) = 8.5 \text{ mA}$$

Hence, the correct answer is (B).

95. Depletion layer contains only fixed positive and negative ions; positive ions on N-side and negative ions on P-side.

Hence, the correct answer is (D).

98. The current will flow through R_L when diode is forward biased.

Hence, the correct answer is (A).

99. In first half cycle junction diode 2 is forward biased and 1 reverse biased; while in next half cycle junction diode 1 is forward biased and 2 is reverse biased. So, contributions from diode 1 are B, D.

Hence, the correct answer is (C).

102. $Y = \overline{A \cdot (A + B)} = \overline{A} + \overline{(A + B)}$

$$\Rightarrow \quad Y = \overline{A} + \overline{A} \cdot \overline{B} = \overline{A}(1 + \overline{B})$$

$$\Rightarrow \quad Y = \overline{A}$$

Hence, the correct answer is (D).

104. $i = \frac{\Delta V}{R} = \frac{V_F - V_B}{R} = \frac{3 - 0.7}{100}$

$$i = 2.3 \times 10^{-2} \text{ A} = 23 \text{ mA}$$

Hence, the correct answer is (D).

106. $\beta = \frac{I_c}{I_b} = \frac{5 \times 10^{-3}}{100 \times 10^{-6}} = 50$

Voltage gain $A_v = \beta\left(\frac{R_0}{R_i}\right) = 5 \times 10^4$

Power gain $A_p = \beta$ (voltage gain)

$$\Rightarrow \quad A_p = 250 \times 10^4 = 2.5 \times 10^6$$

Hence, the correct answer is (A).

107. C, Si and Ge have the same lattice structure and their valence electrons are 4. For C, these electrons are in the second orbit, for Si it is third and for germanium it is the fourth orbit. In solid state, higher the orbit, greater the possibility of overlapping of energy bands. Ionization energies are also less therefore Ge has more conductivity compared to Si. Both are semiconductors and carbon is an insulator.

Hence, the correct answer is (A).

108. Ge conducts at 0.3 V and silicon at 0.7 V. Both Ge and Si diodes are connected in parallel. When current begins to flow, the potential difference remains at 0.3 V, so no current flows through Si-diode.

$\therefore$ Potential difference across

$$R_L = 12 - 0.3 = 11.7 \text{ V}$$

$\therefore$ Potential of $Y = 11.7$ V

Hence, the correct answer is (D).

109. When polarity of Ge diode is reversed, Ge diode is reverse biased, now for conduction potential difference across Si becomes 0.7 V.
So potential difference across

$$R_L = 12 - 0.7 = 11.3 \text{ V}$$

$\therefore$ Potential of $Y = 11.3$ V

Hence, the correct answer is (C).

111. I_Z is maximum when input voltage is 16 V .

$$I_S = \frac{10}{2\times 10^3} = 5 \text{ mA}$$

$$I_L = \frac{6}{4\times 10^3} = 1.5 \text{ mA}$$

$$\Rightarrow \quad I_{Z(\max)} = I_S - I_L = 3.5 \text{ mA}$$

Hence, the correct answer is (D).

112. Output of upper AND gate $= A\overline{B}$

Output of lower AND gate $= B\overline{A}$

Output $Y = A\overline{B} + B\overline{A}$

This is Boolean expression for XOR gate.

Hence, the correct answer is (B).

114. Output of OR gate is 0 when all inputs are 0 and output is 1 when atleast one of the input is 1. Observing output x It is 0 when all inputs are 0 and it is 1 when atleast one of the input is 1. So, OR gate.

Hence, the correct answer is (D).

116. $\Delta E = \dfrac{hc}{\lambda}$

$$\Rightarrow \quad \lambda = \frac{hc}{\Delta E} = \frac{12375}{(\Delta E \text{ in eV})} \text{ Å}$$

$$\lambda = \frac{12375}{1.14} \text{ Å} = 10855 \text{ Å}$$

Hence, the correct answer is (A).

118. $I = neA\mu E$

$$I = \frac{neA\mu V}{L}$$

$$\frac{V}{I} = \frac{L}{neA\mu} = \rho\frac{L}{A}$$

$$\Rightarrow \quad \rho = \frac{1}{ne\mu} = \frac{1}{10^{19}\times 1.6\times 10^{-19}\times 1.6} = \frac{1}{2.56}$$

$$\Rightarrow \quad \rho = 0.4 \ \Omega\text{m}$$

Hence, the correct answer is (C).

119. $I_C = 19$ mA

and $\alpha = \dfrac{I_C}{I_E}$

$$\Rightarrow \quad I_E = \frac{I_C}{\alpha}$$

$$\Rightarrow \quad I_E = \frac{19}{0.95} \text{ mA} = 20 \text{ mA}$$

$$\Rightarrow \quad I_B = I_E - I_C = 20 - 19 = 1 \text{ mA}$$

Hence, the correct answer is (A).

121. $I_b = \dfrac{120 - 50}{5\times 10^3} = \dfrac{70}{5}\times 10^{-3}$

$$\Rightarrow \quad I_b = 14 \text{ mA and } I_L = \frac{50}{10\times 10^3} = 5 \text{ mA}$$

$$\Rightarrow \quad I_Z = 14 - 5 = 9 \text{ mA}$$

Hence, the correct answer is (B).

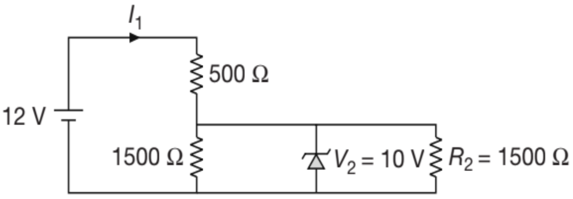
124. $A_v = \beta\dfrac{R_2}{R_1} = 10\times\dfrac{100 \ k\Omega}{20 \ k\Omega} = 50$

$\therefore$ Power gain $= \beta A_v = 10\times 50 = 500$

Hence, the correct answer is (C).

125. As is pentavalent impurity and In is trivalent impurity; so junction, X-Y is reverse biased n-p junction.
Hence, the correct answer is (D).

126.



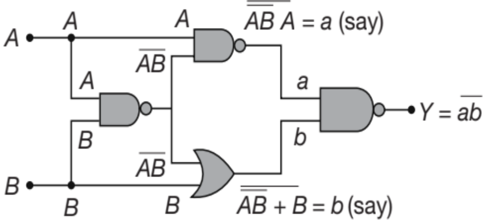
$$(V_{R_2})_{\max} = \frac{12\times 750}{1250}$$

$$(V_{R_2})_{\max} < V_Z$$

So, current through Zener diode is zero.

Hence, the correct answer is (B).

129.



$$a = \overline{\overline{AB}A}$$

$$\Rightarrow \quad a = \bar{A} + \overline{\overline{AB}}$$

$$\Rightarrow \quad a = \bar{A} + AB$$

Now, $b = \overline{AB} + B$

$$\Rightarrow \quad b = \bar{A} + \bar{B} + B$$

$$\Rightarrow \quad b = \bar{A} + (\bar{B} + B)$$

$$\Rightarrow \quad b = \bar{A} + 1 = 1$$

Now $Y = \overline{ab}$

where $a = \bar{A} + AB$ and $b = 1$

$$\Rightarrow \quad Y = \overline{\bar{A} + AB}$$

$$\Rightarrow \quad Y = \bar{\bar{A}}\,\overline{AB} = A(\bar{A} + \bar{B})$$

$$\Rightarrow \quad Y = A\bar{A} + A\bar{B}$$

Since $A\bar{A} = 0$

$$\Rightarrow \quad Y = A\bar{B}$$

Hence, the correct answer is (B).

133. $V_{CC} - I_C R_C = 0$

$$\Rightarrow \quad I_C = \frac{V_{CC}}{R_C} = \frac{5}{1000}\ \text{A}$$

$$V_{BB} - I_B R_B = V_{BE} \qquad \ldots(1)$$

Also, $\beta = \dfrac{I_C}{I_B} = 200$

$$\Rightarrow \quad I_C = 200 I_B$$

$$\Rightarrow \quad I_B = \frac{I_C}{200} = 25\ \mu\text{A}$$

So, from equation (1), we get

$$V_{BB} - 25\times 10^{-6}\times 100\times 10^{3} = 1$$

$$\Rightarrow \quad V_{BB} = 3.5\ \text{V}$$

Hence, the correct answer is (A).

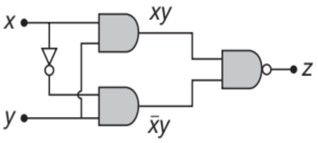
134. $\Delta E = \dfrac{hc}{\lambda} = \dfrac{12375}{\lambda \text{ in Å}}\ \text{eV} = \dfrac{12375}{24800} = 0.5$

Hence, the correct answer is (C).

138. It is *npn* transistor with *R* as collector. If it is connected to base, it will be in forward bias.

Hence, the correct answer is (A).

141.



Output, $z = \overline{(xy)(\bar{x}y)} = \overline{0y} = \bar{0} = 1$

$$\{\because\ x\bar{x} = 0 \text{ and } yy = y\}$$

Whatever be the inputs to the given digital circuit, output will always be one.

Hence, the correct answer is (A).

143. Current in R_1 is $I_1 = \dfrac{5}{500} = 10\times 10^{-3}\ \text{A} = 10\ \text{mA}$

Current in R_2 is $I_2 = \dfrac{10}{1500}\ \text{A} = \dfrac{20}{3}\ \text{mA}$

Current through Zener diode is

$$I_z = I_1 - I_2 = \left(10 - \frac{20}{3}\right)\text{mA} = \frac{10}{3}\ \text{mA} \approx 3.3\ \text{mA}$$

Hence, the correct answer is (B).

144. It is OR gate. When either of them conducts, the gate conducts.

Hence, the correct answer is (A).

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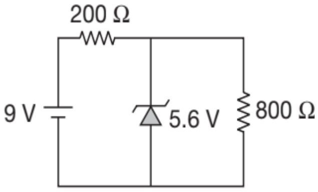
1.



$$I_{800\ \Omega} = \frac{5.6}{800}\ \text{A} = 7\ \text{mA}$$

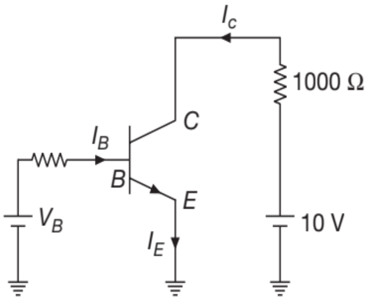
$$I_{200\ \Omega} = \frac{9-5.6}{200} = 17\ \text{mA}$$

$$\Rightarrow\quad I_Z = 17 - 7 = 10\ \text{mA}$$

Hence, the correct answer is (C).

2. For saturation, $V_{CC} - I_C \times R_C = 0$

$$\Rightarrow\quad I_C = \frac{V_{CC}}{R_C} = \frac{10}{10^3} = 10^{-2}\ \text{A}$$



Since, $\beta = \dfrac{I_C}{I_B} = 250$

$$\Rightarrow\quad I_B = \frac{I_C}{250} = \frac{10^{-2}}{250} = 40\ \mu\text{A}$$

Hence, the correct answer is (D).

3. $\beta = \dfrac{I_C}{I_B} = 200$

$$R_i = \frac{10\times 10^{-3}}{15\times 10^{-6}} = 0.67\ \text{k}\Omega$$

So, voltage gain is $A_v = \beta\left(\dfrac{R_o}{R_i}\right) = 300$

Hence, the correct answer is (D).

4. $Y = \overline{\overline{A}\cdot\overline{B}} = A + B$ (Using De-Morgan's Law)

$\Rightarrow$ OR gate

Hence, the correct answer is (A).

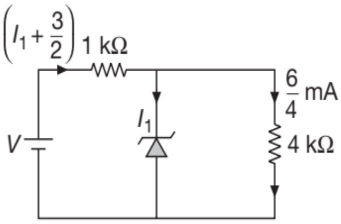
5. $P_{\text{gain}} = \beta^2\left(\dfrac{R_{\text{out}}}{R_{\text{in}}}\right)$ and $I_{\text{gain}} = \beta$

$$\Rightarrow\quad 10^6 = \beta^2\left(\frac{10000}{100}\right)$$

$$\Rightarrow\quad \beta = 100$$

Hence, the correct answer is (C).

6.



$$I_1 = \left(8 - 6 - \frac{3}{2}\right) = \frac{1}{2} = 0.5\ \text{mA}$$

$$I_2 = \left(16 - 6 - \frac{3}{2}\right) = 8.5\ \text{mA}$$

Hence, the correct answer is (B).

7. $Y = \overline{A\cdot(A+B)} = \overline{A} + \overline{(A+B)}$

$$\Rightarrow\quad Y = \overline{A} + \overline{A}\cdot\overline{B} = \overline{A}(1+\overline{B})$$

$$\Rightarrow\quad Y = \overline{A}$$

Hence, the correct answer is (D).

8. $\beta = \dfrac{I_c}{I_b} = \dfrac{5\times 10^{-3}}{100\times 10^{-6}} = 50$

Voltage gain $A_v = \beta\left(\dfrac{R_0}{R_i}\right) = 5\times 10^4$

Power gain $A_p = \beta$ (voltage gain)

$$\Rightarrow\quad A_p = 250\times 10^4 = 2.5\times 10^6$$

Hence, the correct answer is (A).

9. I_Z is maximum when input voltage is $16\ \text{V}$.

$$I_S = \frac{10}{2\times 10^3} = 5\ \text{mA}$$

$$I_L = \frac{6}{4\times 10^3} = 1.5\ \text{mA}$$

$$\Rightarrow\quad I_{Z(\max)} = I_S - I_L = 3.5\ \text{mA}$$

Hence, the correct answer is (D).

10. $I = neA\mu E$

$$I = \frac{neA\mu V}{L}$$

$$\frac{V}{I} = \frac{L}{neA\mu} = \rho\frac{L}{A}$$

$$\Rightarrow \quad \rho = \frac{1}{ne\mu} = \frac{1}{10^{19} \times 1.6 \times 10^{-19} \times 1.6} = \frac{1}{2.56}$$

$$\Rightarrow \quad \rho = 0.4\ \Omega\text{m}$$

Hence, the correct answer is (C).

11. Voltage drop across diode will change from 0.3 to 0.7 V. Value of V_0 changes by 0.4 V.

Hence, the correct answer is (B).

12. $A = \left[\overline{(\bar{X}+\bar{Y}) + \overline{\overline{X\bar{Y}}}}\right]$

$$\Rightarrow \quad A = \overline{\bar{\bar{X}} + Y + \bar{\bar{X}} + Y}$$

$$\Rightarrow \quad A = \left(\overline{\bar{\bar{X}} + Y}\right)$$

Output is 1 when $X = 1$, $Y = 0$

Hence, the correct answer is (C).

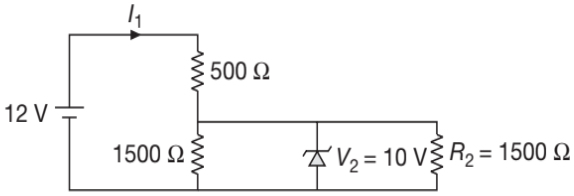
13. $I_b = \dfrac{120-50}{5 \times 10^3} = \dfrac{70}{5} \times 10^{-3}$

$$\Rightarrow \quad I_b = 14\text{ mA} \text{ and } I_L = \frac{50}{10 \times 10^3} = 5\text{ mA}$$

$$\Rightarrow \quad I_Z = 14 - 5 = 9\text{ mA}$$

Hence, the correct answer is (B).

14.



$$\left(V_{R_2}\right)_{\max} = \frac{12 \times 750}{1250}$$

$$\left(V_{R_2}\right)_{\max} < V_Z$$

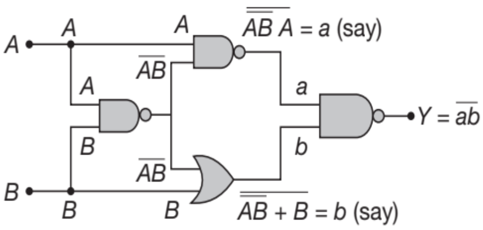
So, current through Zener diode is zero.

Hence, the correct answer is (B).

15. $I = \dfrac{6}{50+150+100} = \dfrac{6}{300}\text{ A} = 0.02\text{ A}$

Hence, the correct answer is (B).

16.



$$a = \overline{\overline{AB}\,A}$$

$$\Rightarrow \quad a = \bar{A} + \overline{\overline{AB}}$$

$$\Rightarrow \quad a = \bar{A} + AB$$

Now, $b = \overline{AB} + B$

$$\Rightarrow \quad b = \bar{A} + \bar{B} + B$$

$$\Rightarrow \quad b = \bar{A} + (\bar{B} + B)$$

$$\Rightarrow \quad b = \bar{A} + 1 = 1$$

Now $Y = \overline{ab}$

where $a = \bar{A} + AB$ and $b = 1$

$$\Rightarrow \quad Y = \overline{\bar{A} + AB}$$

$$\Rightarrow \quad Y = \bar{\bar{A}}\,\overline{AB} = A(\bar{A} + \bar{B})$$

$$\Rightarrow \quad Y = A\bar{A} + A\bar{B}$$

Since $A\bar{A} = 0$

$$\Rightarrow \quad Y = A\bar{B}$$

Hence, the correct answer is (B).

17. $V_{CC} - I_C R_C = 0$

$$\Rightarrow \quad I_C = \frac{V_{CC}}{R_C} = \frac{5}{1000}\text{ A}$$

$$V_{BB} - I_B R_B = V_{BE} \qquad \text{...(1)}$$

Also, $\beta = \dfrac{I_C}{I_B} = 200$

$$\Rightarrow \quad I_C = 200 I_B$$

$$\Rightarrow \quad I_B = \frac{I_C}{200} = 25\ \mu\text{A}$$

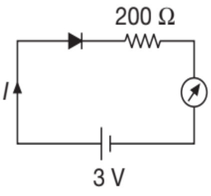
So, from equation (1), we get

$$V_{BB} - 25 \times 10^{-6} \times 100 \times 10^3 = 1$$

$$\Rightarrow \quad V_{BB} = 3.5\text{ V}$$

Hence, the correct answer is (A).

18. Current in the circuit,



$$I = \frac{V - V_{\text{diode}}}{R}$$

$$\Rightarrow \quad I = \frac{3-0.7}{200} = \frac{2.3}{200}\text{ A}$$

$$\Rightarrow \quad I = \frac{2300}{200}\text{ mA} = 11.5\text{ mA}$$

Hence, the correct answer is (C).

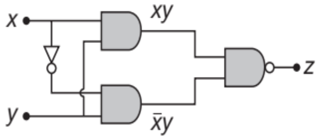
19. Current gain, $\beta=\dfrac{\Delta I_C}{\Delta I_B}$

Voltage gain, $A_V=\dfrac{\Delta V_{CE}}{R_{BE}\Delta I_B}=\beta\dfrac{R_L}{R_{BE}}$

Power gain, $A_P=\beta A_V=\beta^2\dfrac{R_L}{R_{BE}}$

Hence, the correct answer is (B).

20.



Output, $z=\overline{(xy)(\bar{x}y)}=\overline{0y}=\bar{0}=1$

$\{\because x\bar{x}=0 \text{ and } yy=y\}$

Whatever be the inputs to the given digital circuit, output will always be one.

Hence, the correct answer is (A).

21. Current in R_1 is $I_1=\dfrac{5}{500}=10\times10^{-3}\ \text{A}=10\ \text{mA}$

Current in R_2 is $I_2=\dfrac{10}{1500}\ \text{A}=\dfrac{20}{3}\ \text{mA}$

Current through Zener diode is

$$I_z=I_1-I_2=\left(10-\frac{20}{3}\right)\text{mA}=\frac{10}{3}\ \text{mA}\approx3.3\ \text{mA}$$

Hence, the correct answer is (B).

22. In common emitter configuration for *n-p-n* transistor, phase difference between output and input voltage is 180°.

Hence, the correct answer is (D).

23. Forward bias resistance is

$$R_{FB}=\frac{\Delta V}{\Delta I_{\text{for}}}=\frac{0.8-0.7}{(20-10)\times10^{-3}}=\frac{0.1}{10\times10^{-3}}=10$$

Reverse bias resistance, $R_{RB}=\dfrac{10}{1\times10^{-6}}=10^7$ then, the ratio of forward to reverse bias resistance

$$\frac{R_{FB}}{R_{RB}}=\frac{10}{10^7}=10^{-6}$$

Hence, the correct answer is (D).

24. Given that $n_e=5\times10^{18}\ \text{m}^{-3}$, $n_h=5\times10^{19}\ \text{m}^{-3}$,

$\mu_e=2\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$ and $\mu_h=0.01\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$

So, conductivity is

$$\sigma=e(n_e\mu_e+n_h\mu_h)$$

Substituting values, we get

$$\sigma=1.6\times10^{-19}(5\times10^{18}\times2+5\times10^{19}\times0.01)$$

$$\Rightarrow\quad \sigma=1.6\times10^{-19}(10^{19}+0.05\times10^{19})=1.68\ (\Omega\text{m})^{-1}$$

Hence, the correct answer is (B).

25. Since, $\beta=69$, $I_e=7$ mA, $I_c=?$

$$\Rightarrow\quad \alpha=\frac{\beta}{1+\beta}=\frac{69}{70}$$

Also, $\alpha=\dfrac{I_c}{I_e}$

$$\Rightarrow\quad \frac{69}{70}=\frac{I_c}{7}$$

$$\Rightarrow\quad I_c=\frac{69}{70}\times7=6.9\ \text{mA}$$

Hence, the correct answer is (B).

26. Output of *OR* gate is 0 when all inputs are 0 and output is 1 when atleast one of the input is 1. Observing output x It is 0 when all inputs are 0 and it is 1 when atleast one of the input is 1. So, *OR* gate.

(A) Zener diode, Solar cell, Simple diode, Light dependent resistance

(B) Simple diode, Zener diode, Solar cell, Light dependent resistance

(C) Zener diode, Simple diode, Light dependent resistance, Solar cell

(D) Solar cell, Light dependent resistance, Zener diode, Simple diode

Hence, the correct answer is (D).

28. $\alpha=\dfrac{I_C}{I_e}$, $\beta=\dfrac{I_C}{I_b}$

$$I_e=I_b+I_c$$

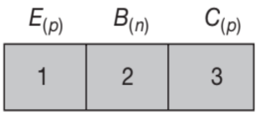
$$\Rightarrow\quad \frac{I_e}{I_c}=\frac{I_b}{I_c}+1$$

$$\Rightarrow\quad \frac{1}{\alpha}=\frac{1}{\beta}+1$$

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

Hence, the correct answer is (A, C).

29. p-n-p transistor

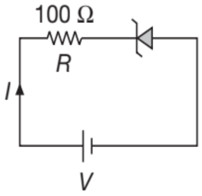


Positive at terminal 2 and negative at terminal 1 implies p-n junction is reverse biased and hence offers high resistance.

Hence, the correct answer is (B).

30. Potential drop across Zener diode

$$V_Z = V - IR = V - 100I$$



Since, power, $P = V_Z I_Z$

$$\Rightarrow \quad P = (V - 100I)I$$

Given that, $P = 1\text{ W}$

$$\Rightarrow \quad (V - 100I)I = 1$$

$$\Rightarrow \quad 100I^2 - VI + 1 = 0$$

For I to be real, $V^2 - 4 \times 100 \times 1 \geq 0$

$$\Rightarrow \quad V \geq 20\text{ V}$$

Hence, the correct answer is (B).

31. The given truth table represents OR gate.
Hence, the correct answer is (A).

32. $R = \dfrac{\text{Output resistance } (r_o)}{\text{Input resistance } (r_i)} \equiv 1 - 10$

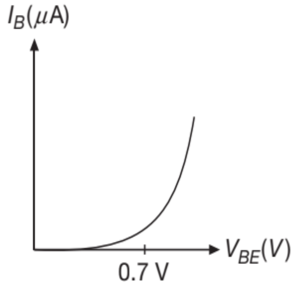
Hence, the correct answer is (B).

33. Output obtained is $Y = (a + b)c$

So, $Y = 1$, when $c = 1$ and $a = 0$, $b = 1$ or $a = 1$, $b = 0$

Hence, the correct answer is (C).

34. For common emitter configuration, the input characteristic



$$r_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

$$\Rightarrow \quad \frac{1}{r_i} = \frac{dI_B}{dV_{BE}} = \text{Slope of } (I_B - V_{BE}) \text{ curve}$$

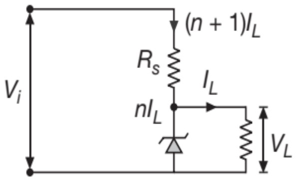
Slope of the input characteristic is almost constant upto knee voltage (0.7 V). Then it increases sharply. Hence option (C) is the correct choice.

Hence, the correct answer is (C).

35. Electron concentration in n-region is more as compared to that in p-region. So, electrons diffuse from n-side to p-side.

Hence, the correct answer is (C).

36.



Voltage drop across Zener diode is V_L, so voltage drop across R_S is,

$$V_{RS} = V_i - V_L = (n+1)I_L R_S$$

$$\Rightarrow \quad R_S = \frac{V_i - V_L}{(n+1)I_L}$$

Hence, the correct answer is (C).

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

$$\Rightarrow \quad \text{Current supplied} = \frac{2\text{ V}}{5\ \Omega} = 0.4\text{ A}$$

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

$$\Rightarrow \quad \text{Current supplied} = \frac{2\text{ V}}{10\ \Omega} = 0.2\text{ A}$$

Hence, the correct answer is (B).

38. Since $I = e^{\frac{1000V}{T}} - 1$

$$\Rightarrow \quad I + 1 = e^{\frac{1000V}{T}}$$

$$\Rightarrow \quad \log_e(I+1) = \frac{1000\text{ V}}{T}$$

$$\Rightarrow \quad d[\log_e(I+1)] = d\left(\frac{1000\text{ V}}{T}\right)$$

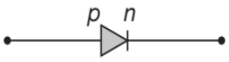
$$\Rightarrow \quad \frac{dI}{I+1} = \left(\frac{1000}{T}\right)dV$$

$$\Rightarrow \quad \frac{dI}{(5+1)mA} = \left(\frac{1000}{300}\right)(0.01)$$

$$\Rightarrow \quad dI = 0.2\text{ mA}$$

Hence, the correct answer is (B).

39.



In forward bias, the p-side of diode is at higher potential with respect to the potential of n-side.

Hence, the correct answer is (B).

40. When wavelength exceeds a certain wavelength, then photoelectric effect ceases to exist.
Hence, the correct answer is (D).

41. $\tau = RC = 100\times10^{3}\times250\times10^{-12}$ s

$\Rightarrow \quad \tau = 2.5\times10^{7}\times10^{-12}$ s

$\Rightarrow \quad \tau = 2.5\times10^{-5}$ s

The higher frequency which can be detected with tolerable distortion is

$$f=\frac{1}{2\pi mRC}=\frac{1}{2\pi\times0.6\times2.5\times10^{-5}}\text{ Hz}$$

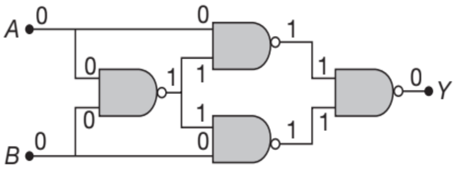
$$\Rightarrow \quad f=\frac{100\times10^{4}}{25\times1.2\pi}\text{ Hz}$$

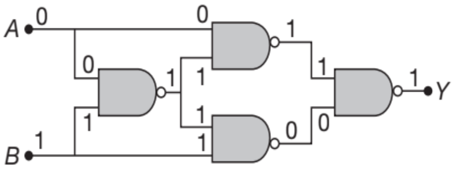
$$\Rightarrow \quad f=\frac{4}{1.2\pi}\times10^{-4}\text{ Hz}$$

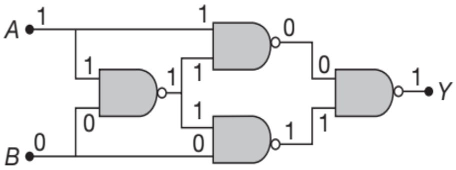
$$\Rightarrow \quad f=10.61\text{ KHz}$$

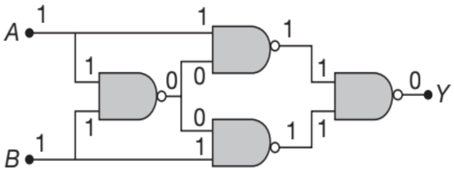
This condition is obtained by applying the condition that rate of decay of capacitor voltage must be equal or less than the rate of decay modulated signal voltage for proper detection of modulated signal.
Hence, the correct answer is (B).

42.



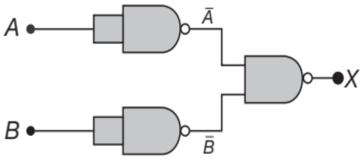






Hence, the correct answer is (D).

43.



The Boolean expression of the given circuit is

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

$$=\bar{\bar{A}}+\bar{\bar{B}} \qquad \text{(Using De Morgan's theorem)}$$

$$=A+B \qquad \text{(Using Boolean identity)}$$

This is same as the Boolean expression of OR gate.

Alternative method

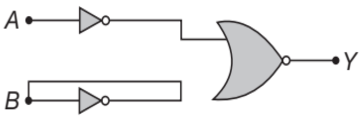
The truth table of the given circuit is as shown in the table

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}\bar{B}$	$X=\overline{\bar{A}\bar{B}}$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

This is same as that of OR gate.

Hence, the correct answer is (B).

44.



By de Morgan's theorem, $\left(\overline{\bar{A}+\bar{B}}\right)=A\cdot B$

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$	$\overline{\bar{A}+\bar{B}}$	$A\cdot B$
1	1	0	0	0	1	1
0	0	1	1	1	0	0
0	1	1	0	1	0	0
1	0	0	1	1	0	0

This is the same as AND Gate of A and B.

Hence, the correct answer is (A).

45. (A) is original wave, (B) is a full-wave rectified, (C) is the correct choice. The negative waves are cut off when the diode is connected in reverse bias, (D) is not the diagram for alternating current.

Hence, the correct answer is (C).