SOLVED EXAMPLES

Ex.1 A doped semiconductor has impurity levesl 30 meV below the conduction band. **(a)** Is the material n-type or p-type ? **(b)** In a thermal collision, an amount kT of energy is given to the extra electron loosely bound to the impurity ion and this electron is just able to jump into the conduction band. Calculate the temperature T.

Sol. **(a)** The impurity provides impurity leves close to the conduction band and a number of electrons from the impurity level will populate the conduction band. Thus, the majority carriers are electrons and the material is n-type.

(b) According to the question, kT = 30 meV

or, $$T = \frac{30\,\text{meV}}{k}$$

$$= \frac{0.03\,\text{eV}}{8.62\times10^{-5}\,\text{eVK}^{-1}} = 348\,\text{K}$$

Ex.2 The energy of a photon of sodium light (λ = 589 nm) equals the band gap of a semiconducting material. (a) Find the minimum energy E required to creat a hole-electron pair. (b) Find the value of E/kT at a temperature of 300 K.

Sol. **(a)** The energy of the photon is $E = \frac{hc}{\lambda}$

$$= \frac{1242\text{eVnm}}{589\,\text{nm}} = 2.1\text{eV}$$

Thus the band gap is 2.1 eV. This is also the minimum energy E required to push an electron from the valence band into the conduction band. Hence, the minimum energy required to creat a hole-electron pair is 2.1 eV.

(b) At $T = 300\,\text{K}$

$$kT = (8.62\times10^{-5}\,\text{eVK}^{-1})(300\,\text{K})$$

$$= 25.86\times10^{-3}\,\text{eV}.$$

Thus, $$\frac{E}{kT} = \frac{2.1\text{eV}}{25.86\times10^{-3}\text{eV}} = 81$$

So it is difficult for the thermal energy to create the hole-electron pair but a photon of light can do it easily.

Ex.3 A p-type semiconductor has acceptor levels 57 meV above the valence band. Find the maximum wavelength of light which can create a hole.

Sol. To create a hole, an electron from the valenec band should be given sufficient energy to go into one of the acceptor levels. Since the acceptor levels are 57 meV above the valence band, at least 57 meV is needed to create a hole.

If λ be the wavelength of light, its photon will have an energy hc/λ. To create a hole,

$$\frac{hc}{\lambda} \geq 57\,\text{meV}$$

or, $$\lambda \leq \frac{hc}{57\,\text{meV}}$$

$$= \frac{1242\,\text{eV nm}}{57\times10^{-3}\,\text{eV}} = 2.18\times10^{-5}\,\text{m}$$

Ex.4 The band gap in germanium is $\Delta E = 0.68$ eV. Assuming that the number of hole-electron pairs is proportional to $e^{-\Delta E/2kT}$, find the percentage increase in the number of charge carriers inpure germanium as the temperature is increased from 300 K to 320 K.

Sol. The number of charge carriers in an intrinsic semiconductor is double the number of hole-electron pairs. If N_1 be the number of charge carriers at temperature T_1 and N_2 at T_2, we have

$$N_1 = N_0 e^{-\Delta E/2kT_1}$$

and $$N_2 = N_0 e^{-\Delta E/2kT_2}$$

The percentage increase as the temperature is raised from T_1 to T_2 is

$$f = \frac{N_2 - N_1}{N_1} \times 100 = \left(\frac{N_2}{N_1} - 1\right) \times 100$$

$$= 100\left[e^{\frac{\Delta E}{2k}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)} - 1\right]$$

Now $$\frac{\Delta E}{2k}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$= \frac{0.68\,\text{eV}}{2 \times 8.62 \times 10^{-5}\,\text{eV K}^{-1}}\left(\frac{1}{300\,\text{K}} - \frac{1}{320\,\text{K}}\right)$$

$$= 0.82.$$

Thus, $f = 100 \times [e^{0.82} - 1] \approx 127.$

Thus, the number of charge carriers increases by about 127%.

Ex.5 The concentration of hol-electron pairs in pure silicon at T = 300 K is 7×10^{15} per cubic metre. Antimony is doped into silicon in a proportion of 1 atom in 10^7 atoms. Assuming that half of the impurity atoms contribute electrons in the conduction band, calculate the factor by which the number of charge carriers increases due to doping. The number of silicon atoms per cubic metre is 5×10^{28}.

Sol. The number of charge cariers before doping is equal to the number of holes plus the number of conduction electrosn. Thus, the number of charge carriers per cubic metre before doping

$$= 2 \times 7 \times 10^{15} = 14 \times 10^{15}.$$

Since antimony is doped in a proportion of 1 in 10^7, the number of antimony atoms per cubic metre is $10^{-7} \times 5 \times 10^{28} = 5 \times 10^{21}$. As half of these atoms contribute electrons to the conduction band, the number of extra conduction electrons produced is 2.5×10^{21} per cubic metre. Thus, the number of charge carriers per cubic metre after the doping is

$$2.5 \times 10^{21} + 14 \times 10^{15}$$

$$\approx 2.5 \times^{21}.$$

The factor by which the number of charge carriers is increased

$$= \frac{2.5 \times 10^{21}}{14 \times 10^{15}} = 1.8 \times 10^5.$$

In fact, as the n-type impurity is doped, the number of holes will decrease. This is because the product of the concentrations of holes and conduction electrons remains almost the same. However, this does not affect our result as the number of holes is anyway too small as compared to the number of conduction electrons.

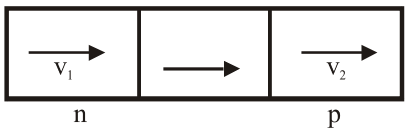
Ex.6 A potential barrier of 0.50 V exists across a p-n junction.

(a) If the depletion regions 5.0×10^{-7} m wide, what is the intensity of the electric field in this region? **(b)** An electron with speed 5.0 × 10 5 ms^{-1} approaches the p-n junction from the n-side. With what speed will it enter the p-side?

Sol. **(a)** The electric field is E = V/d

$$= \frac{0.50V}{5.0\times10^{-7}m} = 1.0\times10^{6}\,Vm^{-1}$$

(b)



Suppose the electron has a speed v_1 when it enters the depletion layer and v_2 when it comes out of it. As the potential energy increases by e × 0.50 V, from the principle of conservation of energy,

$$\frac{1}{2}mv_1^2 = e\times0.50\,V + \frac{1}{2}mv_2^2$$

or, $$\frac{1}{2}\times(9.1\times10^{-31}\,kg)\times(5.0\times10^{5}\,ms^{-2})^2$$

$$= 1.6\times10^{-19}\times0.5\,J + \frac{1}{2}(9.1\times10^{-31}\,kg)\,v_2^{\,2}$$

or, $1.13\times10^{-19}\,J = 0.8\times10^{-19}\,J + (4.55\times10^{-31}\,kg)\,v_2^{\,2}$.

Solving this, $v_2 = 2.7\times10^{5}\,ms^{-1}$.

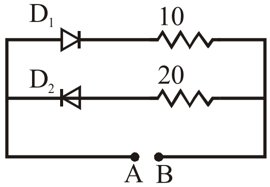
Ex.7 The reverse-biased current of a particular p-n junction diode increases when it is exposed to light of wavelength less than or equal to 600 nm. Assume that the increase in carriers concentration takes place due to the creation of new hole-electron pairs by the light. Find the band gap.

Sol. The reverse-biased current is caused mainly due to the drift current. The drift current in a p-n junction is caused by the formation of new hole-electron pairs and their subsequent motions in the depletion layer. When the junction is exposed to light, it may absorb energy from the light photons. If this energy supplied by a photon is greater than (or equal to) the band gap, a hole-electron pair may be formed. Thus, the reverse-biased current will increase if the light photons have energy greater than (or equal to) the band gap.

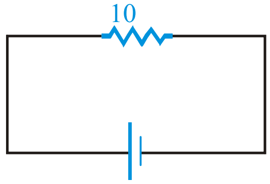
Hence the band gap is equal to the energy of a photon of 600 nm light which is

$$\frac{hc}{\lambda} = \frac{1242\,eVnm}{600\,nm} = 2.07\,eV$$

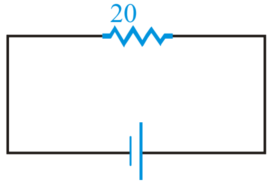
Ex.8 A 2 V battery may be connected across the points A and B as shown in figure. Assume that the resistance of each diode is zero in forward bias and infinity in reverse bias. Find the current supplied by the battery if the positive terminal of the battery is connected to (a) the point A (b) the point B.



Sol. **(a)** When the positive terminal of the battery is connected to the point A, the diode D_1 is forward-biased and D_2 is reverse-biased. the resistance of the diode D_1 is zero, and it can be replaced by a resistanceless wire. Similarly, the resistance of the diode D_2 is infinity, and it can be replaced by a broken wire. The equivalent circuit is shown if figure. The current supplied by the battery is 2 V/10 Ω = 0.2 A.



(a)



(b)

(b) When the positive terminal of the battery is connected to the point B, the diode D_2 is forward-biased and D_1 is reverse biased. the equivalent circuit is shown in figure. The current through the battery is 2 V/20 Ω = 0.1 A.

Ex.9 A change of 8.0 mA in the emitter current brings a change of 7.9 mA in the collector current. How much change in the base current is required to have the same change 7.9 mA in the collector current? Find the values of α and β.

Sol. We have,

$$I_E = I_B + I_C$$

or, $$\Delta I_E = \Delta I_B + \Delta I_C.$$

From the question, when $\Delta I_E = 8.0$ mA, $\Delta I_C = 7.9$ mA.

Thus,

$$\Delta I_B = 8.0\,\text{mA} - 7.9\,\text{mA} = 0.1\,\text{mA}.$$

So a change of 0.1 mA in the base current is required to have a change of 7.9 mA in the collector current.

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

$$= \frac{7.9\,\text{mA}}{8.0\,\text{mA}} \approx 0.99.$$

$$\beta = \frac{I_C}{I_B} = \frac{\Delta I_C}{\Delta I_B}$$

$$= \frac{7.9\,\text{mA}}{0.1\,\text{mA}} = 79.$$

Check if these values of α and β satisfy the equation

$$\beta = \frac{\alpha}{1-\alpha}.$$

Ex.10 A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 20 mV is added to the base-emitter voltage, the base current changes by 20 μA and the collector current changes by 2 mA. The load resistance is 5 kΩ. Calculate **(a)** the factor β, **(b)** the input resistance R_{BE}, **(c)** the transconductance and **(d)** the voltage gain.

Sol. **(a)** $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\,\text{mA}}{20\,\mu\text{A}} = 100.$

(b) The input resistance $R_{BE} = \frac{\Delta V_{BE}}{\Delta I_B}$

$$= \frac{20\,\text{mV}}{20\,\mu\text{A}} = 1\text{k}\Omega$$

(c) Transconductance $= \dfrac{\Delta I_C}{\Delta V_{BE}}$

$$= \frac{2\,\text{mA}}{20\,\text{mV}} = 0.1 \text{ mho.}$$

(d) The change in output voltage is $R_L \Delta I_C$

$= (5\,\text{k}\Omega)\,(2\,\text{mA}) = 10\,\text{V}.$

The applied signal voltage = 20 mV.

Thus, the voltage gain is,

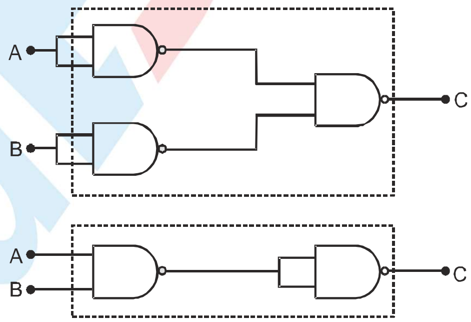
$$\frac{10\,\text{V}}{20\,\text{mV}} = 500.$$

Ex.11 Construct the truth table for the function X of A and B represented by figure.

Sol. Here an AND gate and an OR gate are used. Let the output of the OR gate be Y. Clearly, Y = A + B. The AND gate receives A and A + B as input. The output of this gate is X. So X = (A + B). The following table evaluates X for all combinations of A and B. The last three columns give the truth table.

A	B	Y = A + B	X = A(A + B)	A	B	X
0	0	0	0	0	0	0
0	1	1	0	0	1	0
1	0	1	1	1	0	1
1	1	1	1	1	1	1

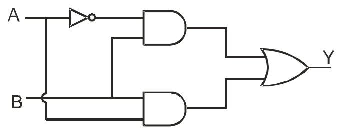
Ex.12 The combination of 'NAND' gates shown here under are equivalent to-



(1) An OR gate and an AND gate respectively
(2) An AND gate and a NOT gate respectively
(3) An AND gate and an OR gate respectively
(4) An OR gate and a NOT gate respectively

Ans. (1)

Ex.13 Truth table for the following is-



(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(3)

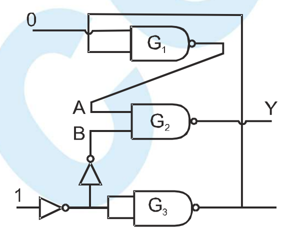
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(4)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Ans. (2)

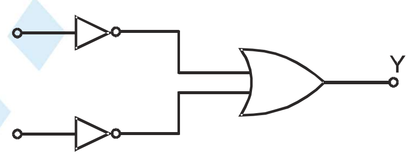
Ex.14 In circuit in following figure the value of Y is-



(1) zero
(2) 1
(3) fluctuates between 0 and 1
(4) indeterminate as the circuit cannot be realized

Ans. (1)

Ex.15 The output Y for the following logic gate circuit will be-



(1) AB **(2)** $\bar{A}\cdot\bar{B}$

(3) $\overline{A+B}$ **(4)** $\overline{A\cdot B}$

Ans. (4)

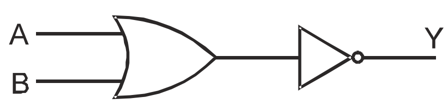
Ex.16 The following truth-table belongs to which one of the four gates-

A	B	X
1	1	0
0	1	0
1	0	0
0	0	1

(1) OR
(2) NAND
(3) XOR
(4) NOR

Ans. (4)

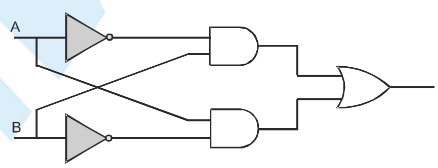
Ex.17 The given circuit is for the gate-



(1) NOR **(2)** NAND
(3) NOT **(4)** XOR

Ans. (1)

Ex.18 The truth table of the logic circuit shown-



(1)

A	B	Y
0	0	0
1	0	1
1	0	1
1	1	1

(2)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(3)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(4)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

Ans. (2)

Sol. It is also called XOR gate the Boolean expression for XOR gate is

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

Exercise # 1 [Single Correct Choice Type Questions]

1. Fermi energy is the-
(A) Minimum energy of electrons in metal at 0 K
(B) Minimum energy of electrons in metal at 0°C
(C) Maximum energy of electrons in metal at 0 K
(D) Maximum energy of electrons in metal at 0°C

2. The forbidden energy band gap in conductors, semiconductors and insulators are EG_1, EG_2 and EG_3 respectively, The relation among them is
(A) $EG_1 = EG_2 = EG_3$
(B) $EG_1 < EG_2 < EG_3$
(C) $EG_1 > EG_2 > EG_3$
(D) $EG_1 < EG_2 > EG_3$

3. Which of the following statements is true-
(A) In insulators the conduction band is completely empty.
(B) In conductor the conduction band is completely empty.
(C) In semiconductor the conduction band is partially empty at low temperature.
(D) In insulators the conduction band is completely filled with electrons.

4. The valence band at 0 K is-
(A) completely filled **(B)** completely empty **(C)** partially filled **(D)** nothing can be said

5. Which of the following statement is true-
(A) At absolute zero temperature, the semiconductor behave as a conductor
(B) The energy gap in semiconductor is more than that for insulator
(C) The resistance of semiconductor increases with increase in temperature
(D) The resistance of semiconductor decreases with increase in temperature

6. An electric field is applied to a semiconductor. Let the number of charge carries be n and the average drift speed be v. If the temperature is increased,
(A) both n and v will increase
(B) n will increase but v will decrease
(C) v will increases but n will decrease
(D) both n and v will decrease

7. Electric conduction in a semiconductor takes place due to
(A) electrons only
(B) holes only
(C) both electrons and holes
(D) neither electron nor holes

8. The free electron concentration (n) in the conduction band of a semiconductor at a temperature T Kelvin is described in terms of E_g and T as-
(A) $n = ATe^{-Eg/kT}$ **(B)** $n = AT^2e^{-Eg/kT}$ **(C)** $n = AT^2e^{-Eg/2kT}$ **(D)** $n = AT^{3/2}e^{-Eg/2kT}$

9. The mobility of free electron is greater than that of free holes because
(A) They carry negative charge
(B) They are light
(C) They mutually collide less
(D) They require low energy to continue their motion

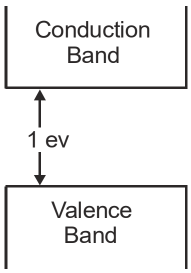
10. Let n_p and n_e be the numbers of holes and conduction electrons in an extrinsic semiconductor
(A) $n_p > n_e$ **(B)** $n_p = n_e$ **(C)** $n_p < n_e$ **(D)** $n_p \neq n_e$

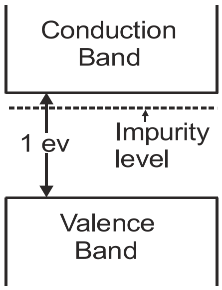
11. The electrical conductivity of pure germanium can be increased by
(A) increassing the temperature
(B) doping acceptor impurities
(C) doping donor impurities
(D) irradiating ultraviolet light on it.

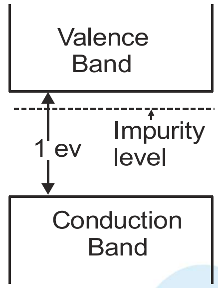
12. A N-type semiconductor is

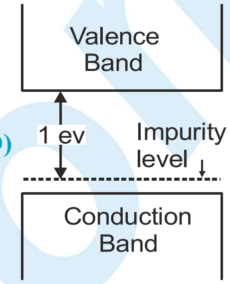
(A) Negatively charged **(B)** Positively charged **(C)** Neutral **(D)** None of these

13. Which of the following energy band diagram shows the N-type semiconductor-

(A) 

(B) 

(C) 

(D) 

14. In a P-type semiconductor, the acceptor level is 57 meV, above the valence band. The maximum wave length of light required to produce a hole will be-

(A) 57 A^o **(B)** 57×10^{-3} A^o **(C)** 217100 A^o **(D)** 11.61×10 A^o

15. If N-type semiconductor is heated then-

(A) The number of electrons increases and the number of holes decreases

(B) The number of holes increases and the number of electrons decreases

(C) The number of electrons and holes both remain equal

(D) The number of both electrons and holes increases equally

16. A P-type silicon semiconductor is made by adding one atom of indium per 5×10^7 atoms of silicon is 25×10^{28} atom/m.^{3}. Point the number of acceptor atoms in per cubic cm. of silicon-

(A) 2×10^{30} atom/cm^3 **(B)** 5×10^{15} atom/cm^3

(C) 1×10^{15} atom/cm^3 **(D)** 2.5×10^{36} atom/cm^3

17. GaAs is-

(A) an elemental semiconductor **(B)** a compound semiconductor

(C) an insulator **(D)** a metallic semiconductor

18. Forbidden energy gap of Ge is 0.75 eV, maximum wave length of incident radiation for producing electron-hole pair in germanium semiconductor is-

(A) 4200 A^o **(B)** 16500 A^o **(C)** 4700 A^o **(D)** 4000 A^o

19. What will be conductance of pure silicon crystal at 300K temp.? If electron hole pairs per cm^3 is 1.072×10^{10} at this temp., μ_n = 1350 cm^2/volt sec and μ_p = 480 cm^2/volt sec-

(A) 3.14×10^{-6} mho/cm **(B)** 3×10^6 mho/cm

(C) 10^{-6} mho/cm **(D)** 10^6 mho/cm

20. The intrinsic carrier density in germanium crystal at 300 K is 2.5×10^{13} per cm^3. If the electron density in an N-type germanium crystal at 300 K be 0.5×10^{17} per cm^3, the hole density (per cm^3) in this N-type crystal at 300 K would be expected around-

(A) 2.5×10^{13} **(B)** 5×10^6 **(C)** 1.25×10^{10} **(D)** 0.2×10^4

21. Mobility of electron in N-type Ge is 5000 cm^2 / volt sec and conductivity 5 mho/cm. If effect of holes is negligible then impurity concentration will be-

(A) 6.25×10^{15} / cm^3 **(B)** 9.25×10^{14} / cm^3

(C) 6×10^{13} / cm^3 **(D)** 9×10^{13} / cm^3

22. The length of a germanium rod is 0.58 cm and its area of cross-section is $1 mm^2$. If for germanium $n_i = 2.5 \times 10^{19}\ m^{-3}$, $\mu_h = 0.19\ m^2/\ V\text{-s}$, $\mu_e = 0.39\ m^2/\ V\text{-s}$, then the resistance of the rod will be -

(A) 2.5 KΩ **(B)** 5.0 KΩ **(C)** 7.5 KΩ **(D)** 10.0 KΩ

23. Pure Si at 300 K has equal electron (n_e) and hole (n_h) concentrations of $1.5 \times 10^{16}\ m^{-3}$. Doping by indium increases n_h to $4.5 \times 10^{22}\ m^{-3}$. Calculate n_e in the doped Si-

(A) $5.0 \times 10^9\ m^{-3}$ **(B)** $6.0 \times 10^6\ m^{-3}$ **(C)** $7.0 \times 10^3\ m^{-3}$ **(D)** $4.0 \times 10^9\ m^{-3}$

24. The P-N junction is-

(A) an ohmic resistance **(B)** an non ohmic resistance

(C) a positive resistance **(D)** a negative resistance

25. The contributions in the total current flowing through a semiconductor due to electrons and holes are $\frac{3}{4}$ and $\frac{1}{4}$ respectively. If the drift velocity of electrons is $\frac{5}{2}$ times that of holes at this temperature, then the ratio of the concentrations of electrons and holes is-

(A) 6 : 5 **(B)** 5 : 6 **(C)** 3 : 2 **(D)** 2 : 3

26. Diffusion current in a p-n junction is greater than the drift current in magnitude

(A) if the junction is forward-biased **(B)** if the junction is reverse-biased

(C) if the junction is unbiased **(D)** in no case

27. The depletion region of a P-N diode, under open circuit condition contains-

(A) Electrons **(B)** Holes

(C) Unmasked immobile impurity ions **(D)** Impurity atoms

28. A hole diffuses from the p-side to the n-side in a p-n junction. This means that

(A) a bond is broken on the n-side and the electron freed from the bond jumps to the conduction band

(B) a conduction electron on the p-side jumps to a broken bond to complete it

(C) a bond is broken on the n-side and the electron freed from the bond jumps to a broken bond on the p-side to complete it

(D) a bond is broken on the p-side and the electron freed from the bond jumps to a broken bond on the n-side to complete it.

29. Depletion layer in P-N junction is caused by-

(A) Drift of holes **(B)** Diffusion of free charge carriers

(C) Migration of impurity ions **(D)** Drift of electrons

30. Which is the wrong statement in following sentence? A device in which P and N type semiconductors are used is more useful then a vacuum tube because-

(A) power is not necesary to heat the filament **(B)** it is more stable

(C) very less heat is producted in it

(D) its efficiency is high due to a high voltage drop across the junction

31. What accounts for the flow of charge carriers in forward and reverse biasing of silicon P-N diode-

(A) Drift in both reverse and forward bias

(B) Drift in forward bias and diffusion in reverse bias

(C) Drift in reverse bias and diffusion in forward bias

(D) Diffusion in both forward and reverse bias

32. The contact potential at the junction site in a P-N junction is-
(A) positive on P side and negative on N side **(B)** negative on P side and positive on N side
(C) zero **(D)** infinite

33. When value of current increase in P-N junction, then the value of contact potential-
(A) decrease **(B)** increase
(C) remain unchanged **(D)** depends on temperature

34. The diffusion current in a P-N junction flows-
(A) from the N-side to the P-side
(B) from the P-side to the N-side
(C) from the N-side to the P-side if the junction is forward-biased and in the opposite direction if it is reverse baised
(D) from the P-side to the N-side if the junction is forward-biased and in the opposite direction if it is reverse biased

35. The barrier potential in a P-N junction is maximum in-
(A) the reverse bias condition
(B) the forward bias condition
(C) the condition when the junction diode is used as rectifier
(D) zero bias condition

36. For a reverse bias P-N junction-
(A) P region is positive and current is due to electrons
(B) P region is positive and the current is due to holes
(C) P region is negative and the current is due to electrons
(D) P region is negative and current is due to both electrons and holes

37. The drift current in a P-N junction flows -
(A) from the N-side to the P-side
(B) from the P-side to the N-side
(C) from the N-side to the P-side if the junction is forward-biased and in the oposite direction if it is reverse biased.
(D) from the P-side to the N-side if the junction is forward-baised and in the opposite direction if it is reverse baised.

38. The value of barrier potential of P-N junction in Ge is-
(A) 0.03 volt in the direction of forward current
(B) 0.3 volt in the direction opposite of the forward current
(C) 25 volt in the direction opposite to the forward current
(D) 25 volt in the direction of the forward current

39. During P-N junction formation when the electron and holes stops moving from P to N and N to P, then
(A) There is increase in number of +ve and –ve ions at junction
(B) There is increase in number of electrons at junction
(C) There is increase in number of holes at junction
(D) There is increase in number of holes and electrons at junction

40. A device whose one end is connected to –ve terminal and other end connected to +ve terminal. If both ends are interchanged with supply then current is not flowing then device will be-
(A) P-N junction **(B)** Transistor **(C)** Zener diode **(D)** Triode

41. Region which have no free electron and holes in a P-N juction is-

(A) P-region **(B)** N-region **(C)** junction **(D)** depletion region

42. The P-N junction diode works as insulator, if connected-

(A) To a.c. **(B)** In forward bias **(C)** In reverse bias **(D)** None of these

43. Potential barrier developed in a junction diode opposes-

(A) Minority carriers in both regions only **(B)** Majority carriers

(C) Electrons in N-region **(D)** Holes in P-region

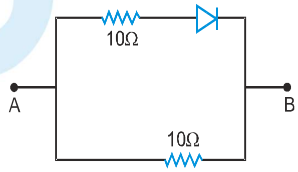
44. The resistance of a reverse baised P-N junction diode is about-

(A) 1 ohm **(B)** 10^2 ohm **(C)** 10^3 ohm **(D)** 10^6 ohm

45. If the forward voltage in a diode is increased, the width of the depletion region-

(A) Decreases **(B)** Increases **(C)** Fluctuates **(D)** does not change

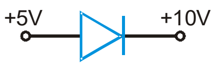
46. If V_A and V_B denote the potentials of A and B, then the equivalent resistance between A and B in the adjoint electric circuit is-



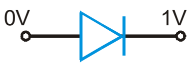
(A) 10 ohm if $V_A > V_B$ **(B)** 5 ohm if $V_A < V_B$

(C) 5 ohm if $V_A > V_B$ **(D)** 20 ohm if $V_A > V_B$

47. In which case is the juction diode is not reverse bias-

(A) 

(B) 

(C) 

(D) 

48. If the two ends of a P-N junction are joined by a wire-

(A) There will not be a steady current in the circuit

(B) There will be a steady current from the N-side to the P-side

(C) There will a steady current from the P-side to the N-side

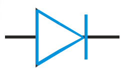
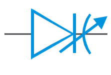
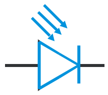
(D) There may or may not be a current depending upon the resistance of the connecting wire.

49. The avalanche breakdown in P-N junction is due to-

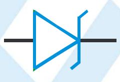
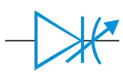
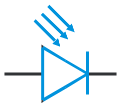
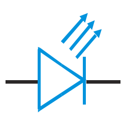
(A) Shift of Fermi level **(B)** Cumulative effect of conduction band electron collision

(C) Widening of forbidden gap **(D)** Low impurity concentration

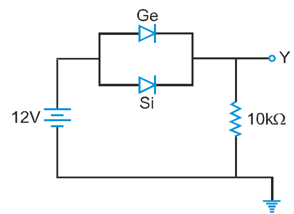
50. Symbol of zener diode-

(A)  **(B)**  **(C)**  **(D)** 

51. Symbolic representation of photodiode is-

(A)  **(B)**  **(C)**  **(D)** 

52. Two junction diodes one of germanium (Ge) and other of silicon (Si) are connected as shown in figure to a battery of emf 12 V and a load resistance 10 kΩ. The germanium diode conducts at 0.3 V and silicon diode at 0.7 V. When a current flows in the circuit, the potential of terminal Y will be-



(A) 12 V **(B)** 11 V **(C)** 11.3 V **(D)** 11.7 V

53. Consider the following statements 1 and 2 and identify the correct answer-

[1] A zener diode is always connected in reverse bias.

[2] The potential barrier of a P-N junction lies between 0.1 to 0.3 V approximately.

(A) [1] and [2] are correct **(B)** [1] and [2] are wrong

(C) [1] is correct, but [2] is wrong **(D)** [1] is wrong, but [2] is correct

54. If the forward voltage in a semiconductor diode is changed form 0.5V to 2V, then the forward current changes by 1.5 mA. The forward resistance of diode will be-

(A) 1KΩ **(B)** 2KΩ **(C)** 4KΩ **(D)** 8KΩ

55. When light falls on a photo diode, its conductivity increases. Experimentally it is found that the conductivity changes only when the wavelength of the incident light is less than 620 nm. The band gap of the diode is-

(A) 0.75 eV **(B)** 1.1 eV **(C)** 1.5 eV **(D)** 2.0 eV

56. If the frequency of input alternating potential is n, then the ripple frequency of output potential of full wave rectifier will be-

(A) 2n **(B)** n **(C)** $\frac{n}{2}$ **(D)** $\frac{n}{4}$

57. When the reverse potential in a semiconductor diode are 10V and 20V, then the corresponding reverse currents are 25μA and 50μA respectively. The reverse resistance of junction diode will be-

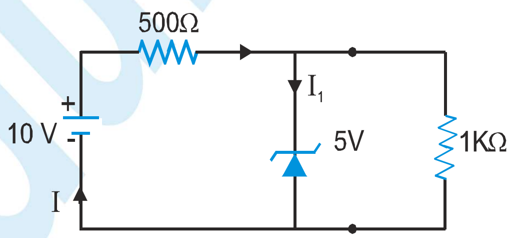
(A) 40Ω **(B)** $4 \times 10^5\ \Omega$ **(C)** 40KΩ **(D)** $4 \times 10^{-5}\ \Omega$

58. Function of rectifier is

(A) To convert ac into dc **(B)** To convert dc into ac

(C) Both (A) and (B) **(D)** None of these

59. The current flowing through the zener diode in fig. is-



(A) 20 mA **(B)** 25 mA **(C)** 15 mA **(D)** 5 mA

60. The electrical circuits used to get smooth d.c. output from a rectified circuit is called

(A) oscillator **(B)** full wave rectifier **(C)** amplifier **(D)** filter

Exercise # 2 Part # I [Multiple Correct Choice Type Questions]

1. A semiconductor is doped with a donor impurity

(A) The hole concentration increases
(B) The hole concentration decreases
(B) The electron concentration increases
(D) The electron concentration decreases

2. Let n_p and n_e be the numbers of holes and conduction electrons in an intrinsic semiconductor

(A) $n_p > n_e$
(B) $n_p = n_e$
(C) $n_p < n_e$
(D) $n_p \neq n_e$

3. In a normal operation of a tranistor,

(A) the base-emitter junction is forward-biased
(B) the base-collector junction is forward-biased
(C) the base-emitter junction is reverse-baised
(D) the base-collector junction is reverse-baised

4. In a p-n junction,

(A) new holes and conduction electrons are produced continuously throughout the material
(B) new holes and cinduction electrons are produced continuously throughout the material except in the depletion region
(C) holes and conduction electrons recombine continuously throughout the material.
(D) holes and conduction electrons recombine continuously throughout the material except in the depletion region.

5 The thinest part of a transistor is-

(A) emitter
(B) base
(C) collector
(D) according to transistor parameters none of these

6. In a transistor-

(A) The emitter has the least concentration of impurity
(B) The collector has the least concentration of impurity
(C) The base has the least concentration of impurity
(D) All the three region have equal concentration of impurity

7. Input resistance of transistor in comparision to output resistance is-

(A) Low
(B) High
(C) Low and high
(D) None of these

8. In transistor symbols, the arrows shows the direction of-

(A) current in the emitter
(B) electron current in the emitter
(B) holes current in the emitter
(D) none of these

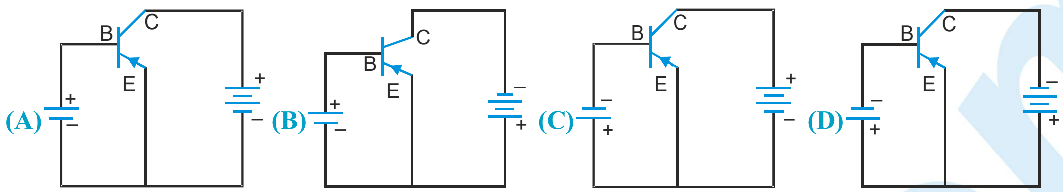
9. In an N-P-N transistor, the emitter current is-

(A) Slightly more than the collector current
(B) Slightly less than the collector current
(C) Equal to the collector current
(D) Equal to the base current

10. In a properly biased transistor-

(A) Both depletion layers are equally large.
(B) Both depletion layers are equally small.
(C) Emitter-base depletion layer is large but base collector depletion layer is small.
(D) Emitter-base depletion layer is small but base-collector depletion layer is large.

11. Which one of the following circuits shows correct biasing of a PNP transistor to operate in active region in the CE mode-



12. A N-P-N transistor conducts when-

(A) Both collector and emitter are positive with respect to the base.

(B) Collector is positive and emitter is negative with respect to the base.

(C) Collector is positive and emitter is at same potential as the base.

(D) Both collector and emitter are negative with respect to the base.

13. An amplifier is nothing but an oscillator with –

(A) positive feedback **(B)** high gain **(C)** no feed back **(D)** negative feed back

14. To use trasistor as an amplifier-

(A) emitter base junction is in forward biased and collector junction is reverse biased.

(B) biasing voltage are not required

(C) both junction are forward biased

(D) both junction are reverse biased

15. A common emitter circuit is used as an amplifier, its current gain is 50. If input resistance is 1 kΩ and input voltage is 5 volt then output current will be-

(A) 250 mA **(B)** 30 mA **(C)** 50 mA **(D)** 100 mA

16. When N-P-N transistor is used as an amplifier-

(A) Electrons move from base to emitter **(B)** Electrons move from emitter to base

(C) Electrons move from collector to base **(D)** Holes move from base to emitter

17. Which of the following is true-

(A) Common base transistor is commonly used because current gain is maximum.

(B) Common-emitter is commonly used because current gain is maximum.

(C) Common collector is commonly used because current gain is maximum.

(D) Common emitter is the least used transistor.

18. In a N-P-N transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector, the emiitter current (I_E) and base current (I_B) are given by-

(A) $I_E = 1mA$; $I_B = 11$ mA **(B)** $I_E = 11$ mA; $I_B = 1$ mA

(C) $I_E = -1$ mA; $I_B = 9$ mA **(D)** $I_E = 9$ mA ; $I_B = -1$ mA

19. For a transistor, $\alpha = 0.9$, the value of β is-

(A) 1 **(B)** 0.09 **(C)** 0.9 **(D)** 9

20. For transistor relation in current amplification factors is-

(A) $\alpha = \dfrac{\beta}{1-\beta}$ **(B)** $\beta = \dfrac{\alpha}{1-\alpha}$ **(C)** $\alpha = \dfrac{1+\beta}{\beta}$ **(D)** $\beta = \dfrac{\alpha}{1+\alpha}$

21. In an NPN transistor 10^{10} electrons emitted from the emitter in 10^{-6} s and 2% electrons recombine with holes in base, then current gain α and β are-

(A) 0.49, 9.8 **(B)** 0.58, 4.9 **(C)** 0.78, 49 **(D)** 0.98, 49

22. In a P-N-P transistor working as a common-base amplifier current gain is 0.96 and emitter current is 7.2 mA The base current is-

(A) 0.4 mA **(B)** 0.2 mA **(C)** 0.29 mA **(D)** 0.35 mA

23. A N-P-N transistor is connected in common emitter configuration in which collector supply is 8 volt and the voltage drop across the load resistor of 800 ohm connected to the collector circuit is 0.8 volt. If current amplification factor α is $\frac{25}{26}$ and the input resistance of the transistor is 200 ohm then the collector emitter voltage, base current, the voltage and power gain are-

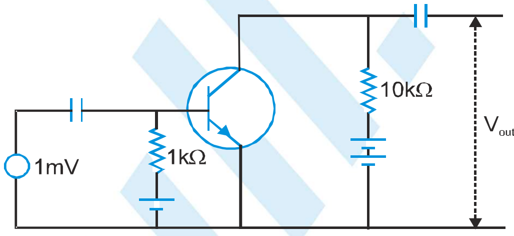
(A) 3.5 V, 2×10^{-5} A and $A_V = 50V$, $A_P = 6500$

(B) 7.2 V, 4×10^{-5} A and $A_V = 100V$, $A_P = 2500$

(C) 4.5 V, 3×10^{-5} A and $A_V = 50V$, $A_P = 6500$

(D) 5.6 V, 3×10^{-5} A and $A_V = 60V$, $A_P = 7500$

24. In the fig. a common emitter configuration on N-P-N transistor with current gain $\beta = 100$ is used. The output voltage of the amplifier will be-



(A) 10 mV **(B)** 0.1 V **(C)** 1.0 V **(D)** 10 V

25. In a common emitter circuit, if V_{CE} is changed by 0.2V, then collector current changed by 4×10^{-3} mA. Output resistance will be-

(A) 10 kΩ **(B)** 30 kΩ **(C)** 50 kΩ **(D)** 70 kΩ

26. The following statement is not true-

(A) The oscillations in an oscillator are maintained.

(B) Oscillator is an active circuit.

(C) There is no voltage gain in an oscillator.

(D) Oscillator works as an amplifier having infinite voltage gain.

27. In an NPN transistor the values of base current and collector current are 100μA and 9 mA respectively, the emitter current will be-

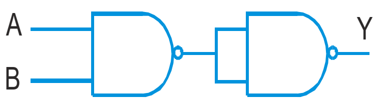
(A) 9.1mA **(B)** 18.2mA **(C)** 9.1μA **(D)** 18.2μA

28. The output of OR gate is 1-

(A) if both inputs are zero **(B)** if either or both inputs are 1

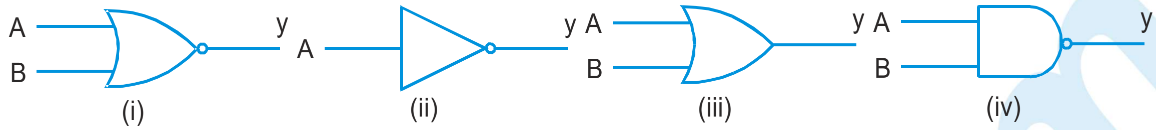
(C) only if both inputs are 1 **(D)** if either input is zero

29. Following diagram performs the logic function of-



(A) AND gate **(B)** NAND gate **(C)** OR gate **(D)** XOR gate

30. Given below are four logic gates symbols. NAND, NOR and OR are respectively-



(A) (iv), (i), (iii) **(B)** (i), (iii), (iv) **(C)** (i), (ii), (iii) **(D)** (i), (iv), (ii)

31. NAND gate is-

(A) a basic gate **(B)** not a universal gate
(C) a universal gate **(D)** none of these.

32. The given truth table is for which logic gate-

A	B	Y
1	1	0
0	1	1
1	0	1
0	0	1

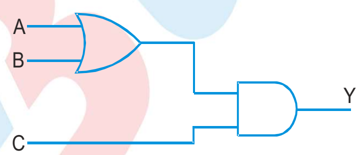
(A) NAND **(B)** XOR **(C)** NOR **(D)** OR

33. Given truth table is for which GATE -

A	B	Y
1	1	1
1	0	0
0	1	0
0	0	0

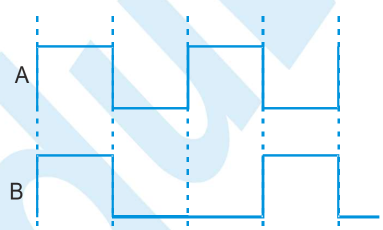
(A) AND **(B)** OR **(C)** NOR **(D)** NAND

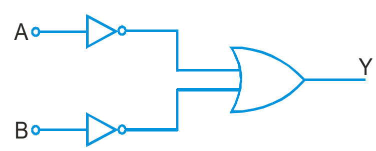
34. For the logic circuit shown the Boolean relation is-



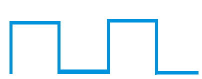
(A) Y = ABC **(B)** Y = A + BC **(C)** Y = (A + B) C **(D)** Y = AB + C

35. In a given circuit as shown the two inputs waveform A and B applied simultaneously.





The resultant wave form Y is-

(A)  **(B)**  **(C)**  **(D)** 

36. The Boolean equation of NOR gate is-

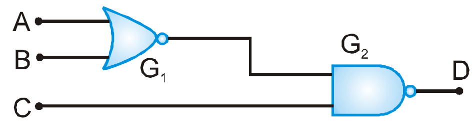
(A) C = A + B **(B)** $C = \overline{A + B}$ **(C)** C = A + B **(D)** $C = \overline{A \cdot B}$

37. According to de Morgan's theorem-

(A) $\overline{A+B+C} = \overline{A}+\overline{B}+\overline{C}$ **(B)** $\overline{ABC} = \overline{A}\,\overline{B}\,\overline{C}$

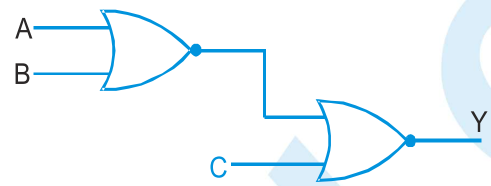
(C) $\overline{ABC} = \overline{A}+\overline{B}+\overline{C}$ **(D)** $\overline{A+B+C} = ABC$

38. For the given combination of gates, if the logic states of inputs A, B, C are as follows A = B = C = 0 and A = B = 1, C = 0 then the logic states of output D are



(A) 0, 0 **(B)** 0, 1 **(C)** 1, 0 **(D)** 1, 1

39. The Boolean expression for the output Y of the logic operation shown, is-



(A) $\overline{(A+B)}+C$ **(B)** $(A+B)+\overline{C}$ **(C)** $\overline{\overline{(A+B)}+C}$ **(D)** $\overline{(A+B+C)}$

40. The depletion layer in silicon diode is 1 μm wide and the knee potential is 0.6 V, then the electric field in the depletion layer will be

(A) Zero **(B)** $0.6\ Vm^{-1}$ **(C)** 6×10^4 V/m **(D)** 6×10^5 V/m

41. What will be the input of A and B for the Boolean expression $\overline{(A+B)} \cdot \overline{(A \cdot B)} = 1$.

(A) 0, 0 **(B)** 0, 1 **(C)** 1, 0 **(D)** 1, 1

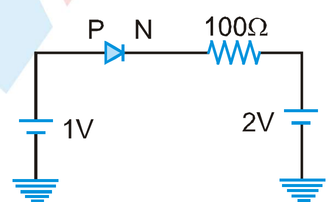
42. In the circuit given below, the value of the current is

(A) 0 amp **(B)** 10^{-2} amp **(C)** 1 amp **(D)** 0.10 amp

43. The maximum efficiency of full wave rectifier is

(A) 100 % **(B)** 25.20 % **(C)** 40.2 % **(D)** 81.2 %

44. The current through an ideal PN-junction shown in the following circuit diagram will be

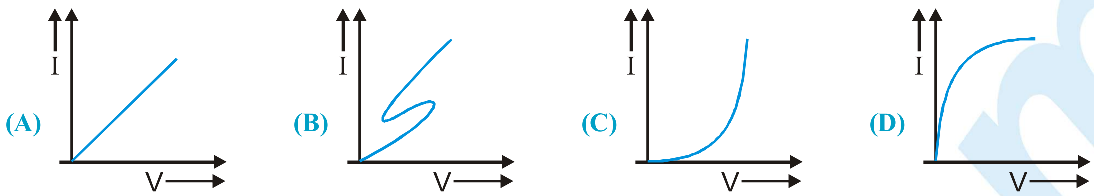


(A) Zero **(B)** 1 mA **(C)** 10 mA **(D)** 30 mA

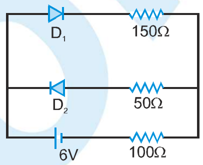
45. In the arrangement shown in fig. the current through diode is-

(A) 10 mA **(B)** 1 mA **(C)** 20 mA **(D)** Zero

46. Choose the correct option for the forward biased characteristics of a p–n junction.



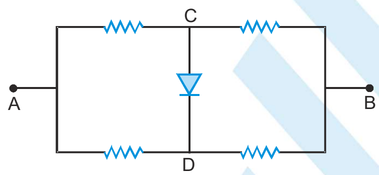
47. The circuit shown in the figure contains two diodes each with a forward resistance of 50 ohm and with infinite reverse resistance. If the battery voltage is 6V, find the current through the 100 ohm resistance-



(A) 0.01 A (B) 0.05 A
(C) 0.02 A (D) 0.03 A

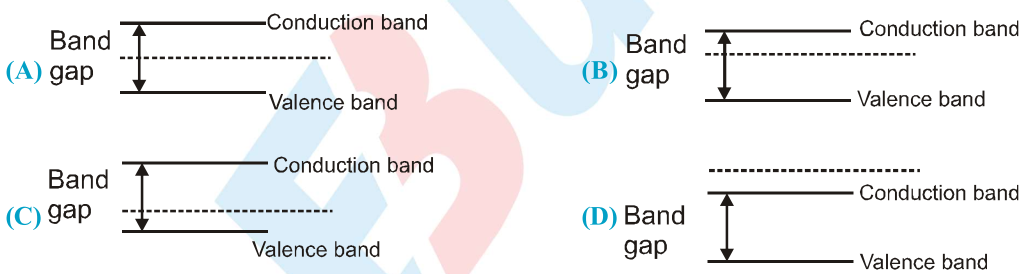
48. In the case of constants α and β of a transistor
(A) $\alpha = \beta$ (B) $\beta < 1, \alpha > 1$ (C) $\alpha\beta = 1$ (D) $\beta > 1, \alpha < 1$

49. Four equal resistors, each of resistance 10 ohm are connected as shown in the adjoining circuit diagram. Then the equivalent resistance between points A and B is-

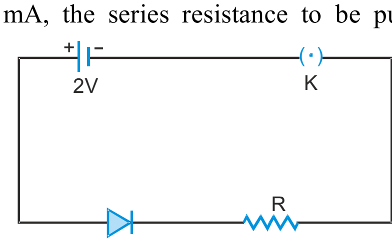


(A) 40 ohm (B) 20 ohm (C) 10 ohm (D) 5 ohm

50. Which one of the following diagrams correctly represents the energy levels in the p–type semiconductor?



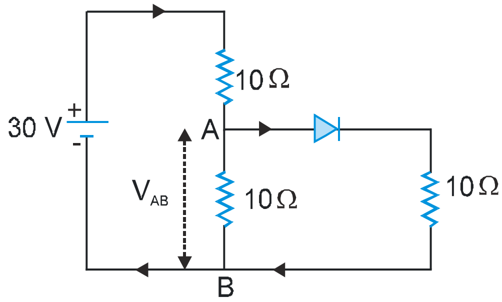
51. A diode made forward biased by a two volt battery however there is a drop of 0.5 V across the diode which is independent of current. Also a current greater then 10 mA produces large joule loss and damages diode. If diode is to be operated at 5 mA, the series resistance to be put is-



(A) 3 KΩ (B) 300 KΩ (C) 300 Ω (D) 200 KΩ

52. If $\alpha = 0.98$ and current through emitter $i_e = 20$ mA, the value of β is
(A) 4.9 (B) 49 (C) 96 (D) 9.6

53. For given circuit potential difference V_{AB} is-



(A) 10 V **(B)** 20 V **(C)** 30 V **(D)** None

54. The ratio of resistance for forward to reverse bias of P–N junction diode is-

(A) $10^{2} : 1$ **(B)** $10^{-2} : 1$ **(C)** $1 : 10^{-4}$ **(D)** $1 : 10^{4}$

55. Zener breakdown will occur if-

(A) Impurity level is low
(B) Impurity level is high
(C) Impurity is less in n-side
(D) Impurity is less in p-side

56. Zener diode is used-

(A) As an amplifier
(B) As a rectifier
(C) As an oscillator
(D) As a voltage regulator

Part # II [Assertion & Reason Type Questions]

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it . Of the statements mark the correct answer as

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

1. **Statement-1 :** The logic gate NOT can be built using diode.

Statement-2 : The output voltage and the input voltate of the diode have 180 phase difference

2. **Statement-1 :** The number of electrons in a P-type silicon semiconductor is less than the number of electrons ina pure silicon semiconductor at room temperature.

Statement-2 : It is due to law of mass action.

3. **Statement-1 :** In a common emitter transistor amplifier the input current is much less than the output current.

Statement-2 : The common emitter transistor amplifier has very high input impedance.

4. **Statement-1 :** A transistor amplifier in common emitter configuration has a low input impedence.

Statement-2 : The base to emitter region is forward biased.

5. **Statement-1 :** The resistivity of a semiconductor increases with temperature.

Statement-2 : The atoms of a semiconductor vibrate with larger amplitude at higher temperature there by increasing it's resistivity.

6. **Statement-1 :** If the temperature of a semiconductor is increased then it's resistance decreases.

Statement-2 : The energy gap between conduction band and valence band is very small.

7. **Statement-1 :** The temperature coefficient of resistance is positive for metals and negative for P-type semiconductor.

Statement-2 : The effective charge carriers in metals are negatively charged whereas in P-type semiconductor they are positively charged.

8. **Statement-1 :** Electron has higher mobility than hole in a semiconductor.

Statement-2 : Mass of electron is less than the mass of hole.

9. **Statement-1 :** An N-type semiconductor has a larger number of electrons but still it is electrically neutral.

Statement-2 : An N-type semiconductor is obtained by doping an intrinsic semiconductor with a pentavalent impurity.

10. **Statement-1 :** The crystalline solids have a sharp melting point.

Statement-2 : All the bonds between the atoms or molecules of a crystalline solids are equally strong, that they get broken at the same temperature.

Exercise # 3 [Subjective Type Questions]

1. Calculate the number of states per cubic metre of sodium in 3s band. The density of sodium is 1013 kgm^{-3}. How many of them are empty?

2. In a pure semiconductor, the number of conduction electrons is 6×10^{19} per cubic metre. How many holes are there in a sample of size 1 cm × 1 cm × 1 mm?

3. Indium antimonide has a band gap of 0.23 eV between the valence and the conduction band. Find the temperature at which kT equals the band gap.

4. The band gap for silicon is 1.1 eV. **(a)** Find the ratio of the band gap to kT for silicon at room temperature 300 K. **(b)** At what temperature does this ratio become one tenth of the value at 300 K? (Silicon will not retain its structure at these high temperatures).

5. When a semiconducting material is doped with an impurity, new acceptor levels are created. In a particular thermal collision, a valence electron receives an energy equal to 2kT and just reaches one of the acceptor levels. Assuming that the energy of the electron was at the top edge of the valence band and that the temperature T is equal to 300 K, find the energy of the acceptor levels above the valence band.

6. Let ΔE denote the energy gap between the valence band and the conduction band. The population of conduction electron (and of the holes) is roughly proportional to $e^{-\Delta E/2kT}$. Find the ratio of the concentration of conduction electrons in diamond to that in silicon at room temperature 300 K. ΔE for silicon is 1.1 eV and for diamond is 6.0 eV. How many conduction electrons are likely to be in one cubic metre of diamond?

7. The conductivity of a pure semiconductor is roughly proportional to $T^{3/2} e^{-\Delta E/2kT}$ where ΔE is the band gap. The band gap for germanium is 0.74 eV at 4 K and 0.67 eV at 300 K. By what factor does the conductivity of pure germanium increase as the temperature is raised from 4 K to 300 K?

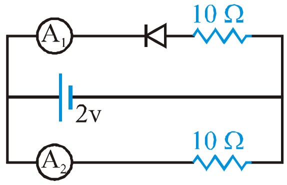
8. Estimate the proportion of boron impurity which will increase the conductivity of a pure silicon sample by a factor of 100. Assume that each boron atom creates a hole and the concentration of holes in pure silicon at the same temperature is 7×10^{15} holes per cubic metre. Density of silicon is 5×10^{28} atoms per cubic metre.

9. The product of the hole concentration and the conduction electron concentration turns out to be independent of the amount of any impurity doped. The concentration of conduction electrons in germanium is 6×10^{19} per cubic metre. When some phosphorus impurity is doped into a germanium sample, the concentration of conduction electrons increases to 2×10^{23} per cubic metre. Find the concentration of the holes in the doped germanium.

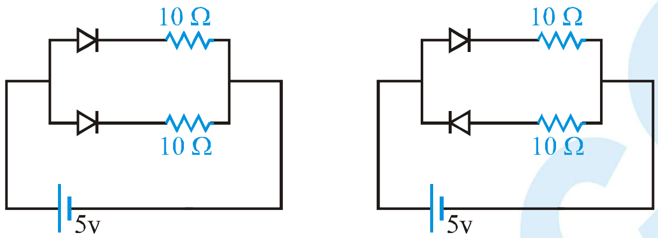
10. The conductivity of an intrinsic semiconductor depends on temperature as $\sigma = \sigma_0 e^{-\Delta E/2kT}$, where σ_0 is a constant. Find the temperature at which the conductivity of an intrinsic germanium semiconductor will be double of its value at T = 300 K. Assume that the gap for germanium is 0.650 eV and remains constant as the temperature is increased.

11. A semiconducting material has a band gap of 1 eV. Acceptor impurities are doped into it which create acceptor levels 1 meV above the valence band. Assume that the transition from one energy level to the other is almost forbidden if kT is less than 1/50 of the energy gap. Also,if kT is more than twice the gap, the upper levels have maximum population.The temperature of the semiconductor is increased from 0 K. The concentration of the holes increases with temperature and after a certain temperature it becomes approximately constant. As the temperature is further increased, the hole concentration again starts increasing at a certain temperature. Find the order of the temperature range in which the hole concentration remains approximately constant.

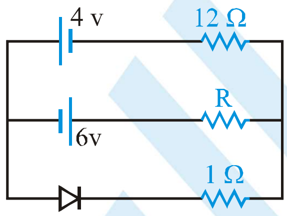
12. What are the readings of the ammeters A_1 and A_2 shown in figure. Neglect the resistances of the meters.



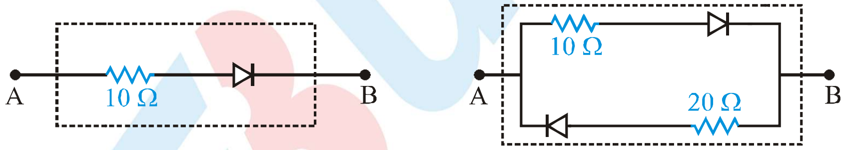
13. Find the current through the battery in each of the circuits shown in figure.



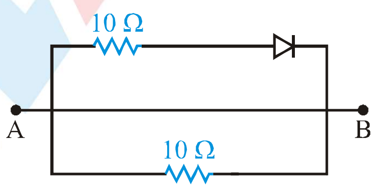
14. Find the current through the resistance R in figure if **(a)** R = 12 Ω **(b)** R = 48 Ω.



15. Draw the current-voltage characteristics for the device shown in figure between the terminals A and B.



16. Find the equivalent resistance of the network shown in figure between the points A and B.



Exercise # 4

Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. At absolute zero, Si acts as : **[AIEEE-2002]**

(1) non-metal (2) metal (3) insulator (4) none of these

2. By increasing the temperature, the specific resistance of a conductor and semiconductor: **[AIEEE-2002]**

(1) increases for both (2) decreases for both

(3) increases, decreases respectively (4) decreases, increases respectively

3. The energy band gap is maximum in : **[AIEEE-2002]**

(1) metals (2) superconductors (3) insulators (4) semiconductors

4. The part of a transistor which is most heavily doped to produce large number of majority charge carries is : **[AIEEE-2002]**

(1) emitter (2) base

(3) collector (4) can be any of the above three

5. A strip of copper and another of germanium are cooled from room temperature to 80 K. The resistance of : **[AIEEE-2003]**

(1) each of these decreases

(2) copper strip increases and that of germanium decreases

(3) copper strip decreases and that of germanium increases

(4) each of these increases

6. The difference in the variation of resistance with temperature in a metal and a semiconductor arises essentially due to the difference in the : **[AIEEE-2003]**

(1) crystal structure

(2) variation of the number of charge carries with temperature

(3) type of bonding

(4) variation of scattering mechanism with temperature

7. When P-N junction diode is forward biased, then- **[AIEEE-2004]**

(1) the depletion region is reduced and barrier height is increased.

(2) the depletion region is widened and barrier height is reduced.

(3) both the depletion region and barrier height are reduced.

(4) both the depletion region and barrier height are increased.

8. When npn transistor is used as an amplifier: **[AIEEE-2004]**

(1) electrons move from base to collector (2) holes move from emitter to base

(3) electrons move from collector to base (4) holes move from base to emitter

9. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm, is incident on it. The band gap in (eV) for the semiconductor is : **[AIEEE-2005]**

(1) 1.1 eV (2) 2.5 eV (3) 0.5 eV (4) 0.7 eV

10. In a common base amplifier, the phase difference between the input signal voltage and output voltage is : **[AIEEE-2005]**

(1) $\frac{\pi}{4}$ (2) π (3) zero (4) $\frac{\pi}{2}$

11. In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be : **[AIEEE-2005]**

(1) 50 Hz (2) 25 Hz (3) 100 Hz (4) 70.7 Hz

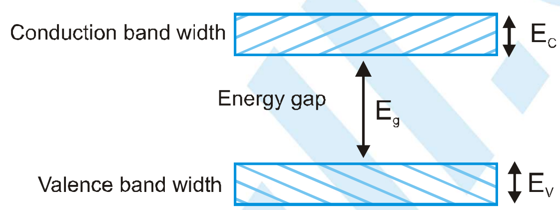
12. If the ratio of the concentration of electrons to that of holes in a semiconductor is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$, then what is the ratio of their drift velocities ? **[AIEEE 2006]**

(1) 5/8 (2) 4/5 (3) 5/4 (4) 4/7

13. In a common–base of mode of transistor, the collector current is 5.488 mA for an emitter current of 5.60 mA. The value of the base current amplification factor (2) will be : **[AIEEE 2006]**

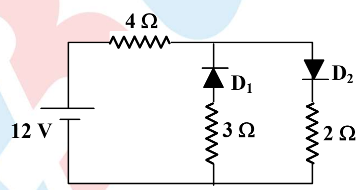
(1) 49 (2) 50 (3) 51 (4) 48

14. If the lattice constant of this semiconductor is decreased, then which of the following is correct? **[AIEEE 2006]**



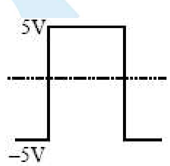
(1) All E_C, E_g, E_v increase (2) E_C and E_V increase, but E_g decreases
(3) E_c and E_v decrease, but E_g increases (4) All E_C, E_g, E_v decrease

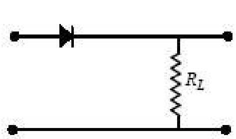
15. The circuit has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit? **[AIEEE 2006]**

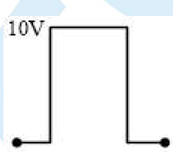


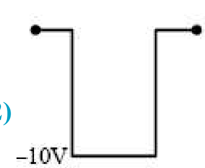
(1) 2.31 A (2) 1.33 A (3) 1.71 A (4) 2.00 A

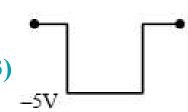
16. If in p-n junction diode, a square input signal of 10 V is applied as shown. Then the output signal across R_L will be **[AIEEE 2007]**

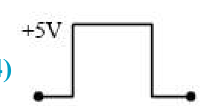




(1) 

(2) 

(3) 

(4) 

17. Carbon, silicon and germanium have four valence electrons each. At room temperature which one of the following statements is most appropriate? **[AIEEE 2007]**

(1) the number of free conduction electrons is significant in *C* but small in *Si* and *Ge*

(2) the number of free conduction electrons is negligibly small in all the three.

(3) the number of free electrons for conduction is significant in all the three.

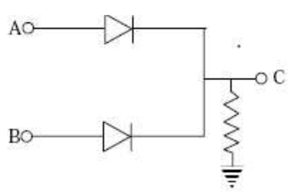
(4) the number of free electrons for conduction is significant only in *Si* and *Ge* but small in *C*.

18. A working transistor with its three legs marked P, Q and R is tested using a multimeter. No conduction is found between P and Q. By connecting the common (negative) terminal of the multimeter to R and the other (positive) terminal to P or Q, some resistance is seen on the multimeter. Which of following is true for the transistor ? **[AIEEE 2008]**

(1) It is a pnp transistor with R as collector **(2)** It is a pnp transistor with R as emitter

(3) It is an npn transistor with R as collector **(4)** It is an npn transistor with R as base

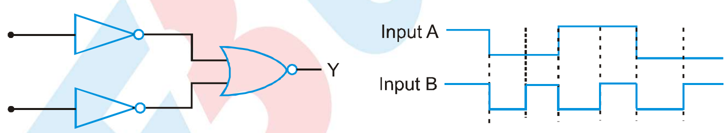
19. In the circuit below, A and B represent two inputs and C represents the output. **[AIEEE 2008]**

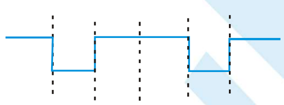
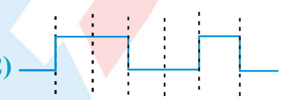
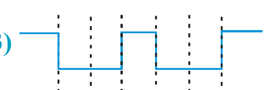
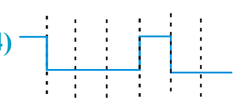


The circuit represents

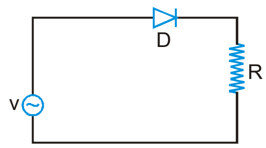
(1) AND gate **(2)** NAND gate **(3)** OR gate **(4)** NOR gate

20. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct out put waveform. **[AIEEE 2009]**

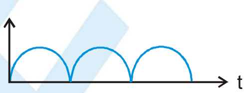
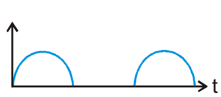
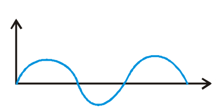


(1)  **(2)**  **(3)**  **(4)** 

21. A p-n junction (4) shown in the figure can act as a rectifier. An alternating current source (V) is connected in the circuit. **[AIEEE 2009]**



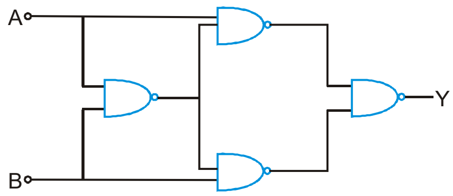
The current (I) in the resistor (R) can be shown by:

(1)  **(2)**  **(3)**  **(4)** 

22. The output of an OR gate is connected to both the inputs of a NAND gate. The combination will serve as a : **[AIEEE 2011]**

(1) NOT gate (2) NOR gate (3) AND gate (4) OR gate

23. Truth table for system of four NAND gates as shown in figure is : **[AIEEE 2012]**



(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

(3)

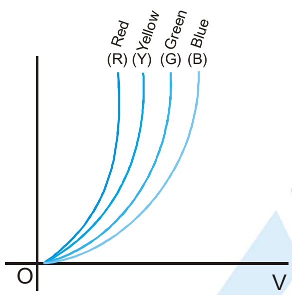
A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(4)

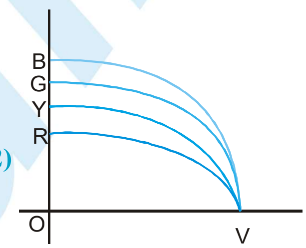
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

24. The I – V characteristic of an LED is : **[JEE-MAIN 2013]**

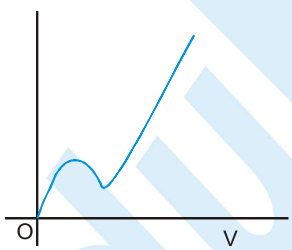
(1)



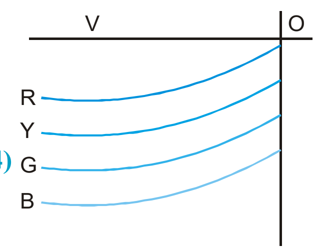
(2)



(3)

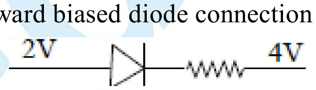


(4)

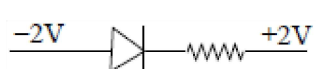


25. The forward biased diode connection is: **[JEE-Main 2014]**

(1)



(2)



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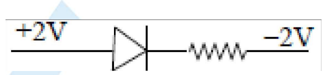
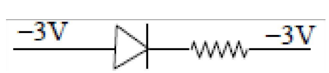
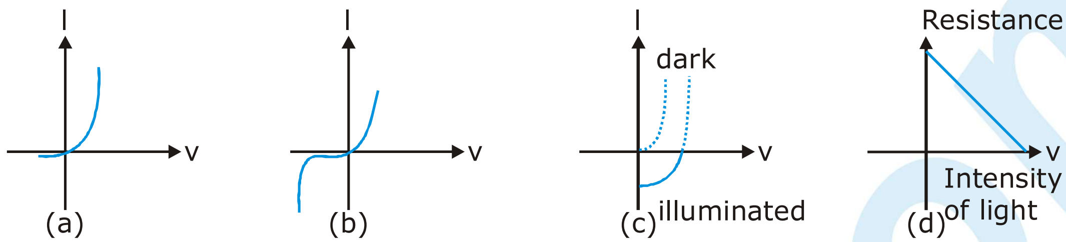


(4)



26. Identify the semiconductor devices whose characteristics are given below, in the order **(1)**, **(2)**, **(3)**, **(4)** :
[JEE-Main 2016]



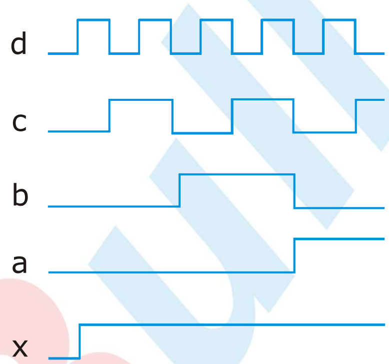
(1) Zener diode, Simple diode, Light dependent resistance, Solar cell

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

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

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

27. If a, b, c, d are inputs to a gate and x is its output, then, as per the following time graph, the gate is :
[JEE-Main 2016]



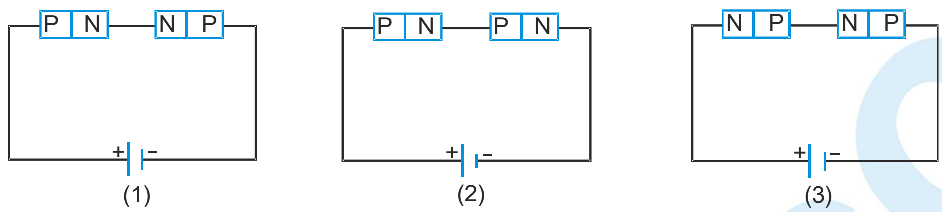
(1) AND **(2)** OR **(3)** NAND **(4)** NOT

28. For a common emitter configuration, if α and β have their usual meanings, the incorrect relationship between α and β is :
[JEE-Main 2016]

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

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. Two identical P-N junction may be connected in series with a battery in three ways (fig below). The potential drops across the two P-N junction are equal in- **[IIT-1988]**



(A) Circuit 1 and 2 **(B)** Circuit 2 and 3 **(C)** Circuit 3 and 1 **(D)** Circuit 1 only

2. In a P-N junction diode which is not connected to any circuit- **[IIT-1998]**

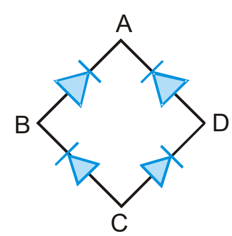
(A) Potential is the same every where

(B) The P-type side is at a higher potential than the N-type side

(C) There is an electric field at the junction directed from the N-type side to the P-type side

(D) There is an electric field at the junction directed from the P-type side to the N-type side

3. For the given circuit shown in fig, to act as full wave rectifier, a.c. input should be connected across ....and........the d.c. output would appear across........and........ **[IIT-1991]**



(A) A, C and B, D

(B) B, D and A, C

(C) A, B and C, D

(D) C, A and D, B

4. In a......biased P-N junction the net flow holes is from N-region to the P-region- **[IIT-1993]**

(A) forward **(B)** reverse **(C)** no **(D)** both 1 and 2

ANSWER KEY

EXERCISE - 1

1. C	**2.** B	**3.** A	**4.** A	**5.** D	**6.** B	**7.** C	**8.** D	**9.** D	**10.** D	**11.** B	**12.** C	**13.** B
14. C	**15.** D	**16.** B	**17.** B	**18.** B	**19.** A	**20.** C	**21.** A	**22.** A	**23.** A	**24.** B	**25.** A	**26.** A
27. C	**28.** C	**29.** B	**30.** D	**31.** C	**32.** B	**33.** A	**34.** B	**35.** A	**36.** D	**37.** A	**38.** B	**39.** A
40. A	**41.** D	**42.** C	**43.** B	**44.** D	**45.** A	**46.** C	**47.** B	**48.** A	**49.** B	**50.** A	**51.** C	**52.** D
53. C	**54.** A	**55.** D	**56.** A	**57.** B	**58.** A	**59.** D	**60.** D					

EXERCISE - 2 : PART # I

1. B,C	**2.** A, B, C, D	**3.** A,D	**4.** A, D	**5.** B	**6.** C	**7.** A	**8.** A	**9.** A	**10.** D	**11.** D	**12.** B	**13.** A
14. A	**15.** A	**16.** B	**17.** B	**18.** B	**19** D	**20.** B	**21.** D	**22.** C	**23.** B	**24.** C	**25.** C	**26.** C
27. A	**28.** B	**29.** A	**30.** A	**31.** C	**32.** A	**33.** A	**34.** C	**35.** A	**36.** B	**37.** C	**38.** D	**39.** C
40. D	**41.** A	**42.** B	**43.** D	**44.** A	**45.** D	**46.** C	**47.** C	**48.** D	**49.** C	**50.** C	**51.** C	**52.** B
53. A	**54.** D	**55.** B	**56.** D									

PART # II

1. D	**2.** A	**3.** C	**4.** A	**5.** D	**6.** A	**7.** B	**8.** A	**9.** B	**10.** A

EXERCISE - 3 : PART # I

1. 5.3×10^{28}, 2.65×10^{28}
2. 6×10^{12}
3. 2670 K
4. **(a)** 43 **(b)** 3000 K
5. 50 meV
6. 2.3×10^{-33}, almost zero
7. approximately 10^{463}
8. 1 in about 3.5×10^{10}
9. 1.8×10^{16} per cubic metre
10. 318 K
11. 20 to 230 K
12. zero, 0.2 A
13. **(a)** 1 A **(b)** 0.5 A
14. **(a)** 0.42 A, **(b)** 0.13 A
16. $5\,\Omega$ if $V_A > V_B$ and $10\,\Omega$ if $V_A < V_B$

EXERCISE - 4 : PART # I

1. 3	**2.** 3	**3.** 3	**4.** 1	**5.** 3	**6.** 2	**7.** 3	**8.** 4	**9.** 3	**10.** 3	**11.** 3	**12.** 3	**13.** 1
14. 3	**15.** 4	**16.** 4	**17.** 4	**18.** 4	**19.** 3	**20.** 4	**21.** 2	**22.** 2	**23.** 1	**24.** 1	**25** 3	**26** 4
27 2	**28** 1,3											

PART # II

1. B **2.** C **3.** B **4.** B