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Class: 12
Subject: Physics
Topic: Electronic Devices
No. of Questions: 22

1. The resistance of p-n junction is low when forward biased and is high when reverse biased. Explain.

   Sol.

   A small increase in forward voltage across p-n junction shows large increase in forward current. Hence the resistance (= voltage/current) of p-n junction is low when forward biased.

   A large increase in reverse voltage across p-n junction shows small increases in reverse current. Hence the resistance of p-n junction is high when reverse biased.

2. Why are Si and GaAs preferred materials for solar cells?

   Sol.

   The energy for the maximum intensity of the solar radiation is nearly 1.5 eV. In order to have photo excitation the energy of radiation (hv) must be greater than energy band gap (E_g). Therefore, the semiconductor with energy band gap equals to or less than 1.5 eV or lower and with higher absorption coefficient, is likely to give better solar conversion efficiency. The energy band gap for Si is about 1.1 eV, while for GaAs, it is about 1.53 eV. The GaAs is better inspite of its higher band gap than Si because it absorbs relatively more energy from the incident solar radiations being of relatively higher absorptions coefficient. We do not use materials having band gap more than 1.5 eV because for such materials most of the solar radiations fo energy more than 1.5 eV are absorbed on the top layer of the solar cell and do not reach in or near the depletion region. Due to it, only a small portion of higher solar energy is used for photo-conversion whereas the significant part of the solar energy is of no use.

3. How reverse current suddenly increases at the breakdown voltage in case of zener diode?

   Sol.

   We know that the reverse current through the junction diode is due to flow of minority carries (i.e., flow of electrons from p to n-side and holes from n to p-side of p-n junction diode). As the reverse bias voltage across the junction is increased, the electric field at the junction becomes significant. When the reverse bias voltage becomes equal to Zener voltage (i.e. $V = V_z$), then the electric field strength across the junction becomes quite high. This electric field across the junction is sufficient to pull valence electrons from the host atoms on the p-side and accelerate

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them towards n-side. The movement of these electrons across the junction accounts for high current which is observed at the break down reverse voltage.

4. What will happen if emitter be reverse-biased and collector be forward biased in a transistor?

   Sol.

   In a transistor, if emitter is reverse biased and collector is forward biased, then the emitter will work as collector and the collector will work as emitter. It means the transistor will work as usual but with lower amplification as the size of emitter is smaller than that of collector but doping of emitter is more than that of collector. This shows that the transistor enjoys bidirectional facility.

5. A transistor is current operated device. Explain.

   Sol.

   In a transistor, emitter current = base current + collector current. It means emitter current controls the collector current and base current. For a given emitter current, collector current is controlled by base current. Therefore, the change in collector current is related with the base current and not to the base voltage change. That is why, the transistor is a current operating device.

6. Explain, why the input resistance of a transistor is low and output resistance is high.

   Sol.

   While using a transistor, the emitter-base junction is always forward biased and collector-base junction is always reverse-biased. Due to it, a small change in emitter voltage produces a large change in emitter current. This means that a small signal voltage variation at the input resistance of the transistor produces a large emitter current variation. This shows that the input resistance of a transistor low.

   Since collector is reverse-biased. It collects all the charge carriers which diffuse into it, through base. Due to it, a very large change in collector voltage shows only a small change in the collectors current. This shows that output resistance of the transistor is high.

7. How will you test in a simple way whether a transistor is spoiled or in working order?

   Sol.

   A transistor has two junction; one junction between emitter and base and other between base and collector. A junction of transistor has low resistance when forward biased and high resistance when reverse biased. In a spoiled transistor, the resistance of the junction is found to be low when forward biased or reverse biased, which can be checked using AVO-meter.

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8. Draw and explain the output waveform across the load resistor R, if the input wave form is as shown in Fig. 9(b).48.

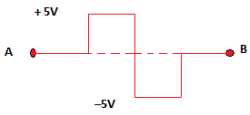

Figure 9(b).48

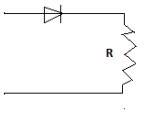

Figure 9(b).49.

Sol.

When the input voltage is + 5 V, the p-n junction diode is forward biased. The output voltage across R is + 5 V. When the input voltage is –5 V, the p-n junction diode gets reverse biased. Therefore, the output voltage across R is zero. The output wave form is as shown in Fig. 9(b).49.

9. In a transistor, forward bias voltage is always low as compared to reverse bias voltage. Why?

Sol.

In a transistor, emitter-base junction is forward biased with low voltage battery and collector-base junction is reverse biased with high voltage battery. If forward bias voltage s made large, the majority carriers in emitter will drift towards the collector through base region with large velocity. Since their number is also large, a large hear is produced which breaks up the covalent bonds and the transistor gets spoiled. However, if the reverse bias voltage applied to collector is large, it simply collects the majority carriers easily, coming from emitter through base, but no heating effect is produced nor breaking of covalent bond takes place in transistor.

10. In a common emitter transistor circuit, a both B and a voltmeter V are connected as shown in fig. 9(b).51. What changes would take place in bulb B and voltmeter V when the value of resistance R is increased?

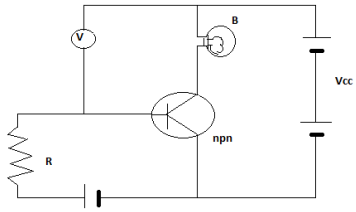

Figure 9(b).51.

Sol.

When the value of resistance R is increased, then the input current (i.e., base current) would decrease. Due to it, the current (i.e., collector current) would decrease. Due to it, the bulb B glows dim. The decrease in the input current can be interpreted as the decrease in the base emitter voltage (V_{BE}). If V is the voltage across the collector-base circuit then in a closed circuit.

$$V_{cc} = V+V_{BE} \qquad \text{or } V=_{Vcc}–V_{BE}$$

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When V_{BE} decreases V increases. It means voltmeter will show higher voltage.

11. In the emitter and base of a n-p-n transistor have same doping concentration, explain how will the collector and base currents be affected?

Sol.

In a transistor, base brings interaction between emitter and collector. In a transistor, the base region is made very thin and lightly doped as compared to that of emitter so that there may be less recombination of electrons and holes in this region. Due to which the base current is quite weak and the collector current is nearly equal to the emitter current.

If the base region of a transistor is doped equally to that of emitter region, then a large electron hole recombination will take place in base, due to which base current would increase but collector current would decrease. Then the very purpose of a transistor would defeated.

12. The gain of a common emitter amplifier is given by $A_v = -g_m R_L$. Does it mean that if we keep on increasing indefinitely R_L, the gain of the amplifier also increase indefinitely? Explain your answer.

Sol.

The gain of the amplifier will not increase indefinitely on increasing R_L Indefinitely.

As $V_C = V_{CE} - I_C R_L$

Therefore, as R_L increases, the value of V_C decreases. When the value of V_C becomes less than the base voltage, both the junctions in transistor get forward biased. Due to it, the current becomes saturated. It means no further increase of current takes place and hence no further gain of the amplifier.

13. In radio and television broadcast, the information signal is in the form of

A. analog signal
B. digital signal
C. both analog and digital signals
D. neither analog nor digital signal

Right Answer Explanation:
The correct choice is (1).

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14. Through which mode of communication can radio waves be sent from one place to another?

A. Ground wave propagation
B. Sky wave propagation
C. Space wave propagation
D. All of the above

Right Answer Explanation:
The correct choice is (4).

15. Which mode of communication is employed to transmit very high frequency (VHF) and ultra high frequency (UHF) signals?

A. Ground wave propagation
B. Sky wave propagation
C. Space wave propagation
D. None of these

Right Answer Explanation:
The correct choice is (3).

16. A receiving station on the ground is receiving a signal of frequency 5 MHz from a transmitter at a height of 300 m above the surface of the Earth (radius = 6.4×10^6 m) at a distance of 100 km from the receiver. The signal is coming via

A. ground wave propagation
B. sky wave propagation
C. both ground wave and sky wave propagation
D. neither ground wave nor sky wave propagation

Right Answer Explanation:
For ground wave propagation, the maximum range is

$$d_{max} = \sqrt{2\,Rh} = \sqrt{2 \times 6.4 \times 10^6 \times 300}$$

$$\simeq 62 \times 10^3 \text{ m} \simeq 62 \text{ km}$$

which is less than 100 km. Hence, choice (1) is wrong. The maximum frequency which can be propagated via sky waves is

$$v_{max} = 9 \text{ MHz}$$

which is more than 5 MHz. Hence, a 5 MHz signal can be propagated via sky waves and not via ground waves.

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17. The addition of a minute quantity of antimony to a silicon crystal makes it

A. a good insulator
B. a good conductor
C. a p-type semiconductor
D. an n-type semiconductor

Right Answer Explanation:
Antimony is pentavalent. Hence the correct choice is (4).

18. To obtain a p-type semiconductor germanium crystal, it must be doped with foreign atoms whose valency is

A. 2
B. 3
C. 4
D. 5

Right Answer Explanation:
The correct choice is (2).

19. A piece of copper and another of germanium are cooled from room temperature to 80 K. The resistance of

A. each of them increases
B. each of them decreases
C. copper increases and that of germanium decreases
D. copper decreases and that of germanium increases

Right Answer Explanation:
We know that the resistance of a good conductor decreases with decrease of temperature. On the other hand the resistance of a semi-conductor increases as temperature decreases. Since copper is a good conductor, its resistance decreases as temperature decreases from room temperature to 80 K. On the other hand, germanium, being a semi-conductor, its resistance increases as temperature decreases. Hence the correct choice is (4).

20. In a half-wave rectifier, the rms value of the ac component of the wave is

A. equal to dc value
B. more than dc value
C. less than dc value
D. zero

Right Answer Explanation:
The correct choice is (2).

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21. In a typical transistor, the collector current is

A. slightly less than the emitter current
B. slightly more than the emitter current
C. equal to the emitter current
D. equal to the base current

Right Answer Explanation:
The correct choice is (1).

22. In a transistor, the value of the base current depends on

A. base thickness only
B. bias voltages only
C. doping levels of emitter, base and collector only
D. all the above factors

Right Answer Explanation:
The correct choice is (4).