Chapter 17: Electronics

P17

1. What is electronics?

Electronics is a field of physics and engineering dealing with the design and application of electronic devices.

2. What are conductors? Give example.

Substances that allow electric current to pass through them are called conductors.
Example: Metals like copper, aluminium etc.

3. What are insulators? Give example.

Substances that do not allow electric current to pass through them are called insulators.
Example: Plastic, rubber, wood, glass etc.

4. Mention some electronic gadgets.

Mobile phone, Laptop, tablet, computers, ultra sound scanner, X-ray etc.

5. Which are the areas influenced by electronics?

Electronics has influenced communications, medical science, laser technology, nano technology etc.

6. What are semiconductors? Give example.

Substances that have conductivity between that of conductors and insulators are called semiconductors. Example: Silicon, Germanium

7. Distinguish between conductors and semiconductors.

Conductors	Insulators
Conduction is very high	Conduction is very low
Resistance is low	Resistance is higher than that of conductors
On heating resistance increases	On heating resistance decreases

8. Why is silicon an insulator at room temperature?

Silicon has 4 valence electrons. Each atom forms 4 covalent bonds with its four neighbouring atoms. At room temperature, the electrons are bound to the atom and are not free. Hence semiconductors behave as insulators at room temperature.

9. What is the reason for the conductivity of semiconductors?

Semiconductors require a small amount of energy to break the covalent bond to set the electron free. Thus as the temperature increases, the number of electrons dissociated from their atoms increases. Thus semiconductors behave as conductors.

10. Give reason:

a) 14^{th} group electrons are semiconductors except carbon.

The valence electrons have a low energy that they cannot become free by absorbing normal energy from the surroundings.

b) Silicon is more widely used than germanium.

Silicon and germanium have same 4 valence electrons but silicon can be used at higher temperatures, cheaper and abundantly available.

11. Explain the term 'hole' in electronics.

When an electron is detached from the co-valent bond, it leaves a vacancy which behaves like a positive charge. This vacancy is called a hole.

12. What is an intrinsic semiconductor or pure semiconductor?

A semiconductor in which the number of holes and electrons are equal is called intrinsic or pure semiconductor.

13. What is an extrinsic semiconductor or doped?

A semiconductor whose conductivity is enhanced by addition of minute traces of impurities is called doped or extrinsic semiconductor.

14. Write differences between intrinsic and extrinsic semiconductors.

Intrinsic semiconductor	Extrinsic semiconductor
They are crystals of pure elements like germanium or silicon.	They are formed by adding impurity atoms to a pure semiconductor.
The number of electrons is equal to number of holes	The number of electrons is not equal to number of holes
Electrical conductivity is less	Electrical conductivity is more

15. What are dopants?

A dopant is a substance (impurity) that is added in traces to increase the conductivity of a semiconductor.

16. What is meant by doping?

The process of adding dopants to enhance the conductivity of semiconductors is called doping.

17. How are extrinsic semiconductors classified?

Extrinsic semiconductors are classified into two types depending upon the type of impurity added into

a) n-type semiconductor

b) p-type semiconductors.

18. Explain the formation of an n-type semiconductor.

When a small amount of a penta valant impurity like antimony, arsenic or phosphorous is added to a tetra valant element like Silicon or Germanium, four out of five electrons of each impurity atoms forms a bond with the nearest silicon atom. The fifth electron is free and acts as current carrier. The impurity added donates an electron to the semiconductor and becomes an n-type semiconductor. In an n-type semiconductor the majority charge carriers are electrons.

19. Explain the formation of a p-type semiconductor.

When a small amount of a trivalent impurity like Boron, Indium, Aluminium or Gallium is added to a tetra valant element like Silicon or Germanium, three electrons of each impurity atoms forms a bond with the nearest silicon atom. The fourth bond remains incomplete which has a deficiency of one electron. This results in the creation of a hole. This hole attracts electrons from the neighbouring covalent bond. The impurity atom accepts electron from the semiconductor and becomes n-type semiconductor. In an n-type semiconductor the majority charge carriers are holes.

20. Distinguish between n-type and p-type semiconductor.

n-type semiconductor	p-type semiconductor
It is formed by adding a pentavalent impurity to a pure semiconductor.	It is formed by adding a trivalent impurity to a pure semiconductor.
Free electrons act as charge carrier	Holes act as charge carrier
Majority charge carriers are electrons	Majority charge carriers are holes

21. What is a semiconductor diode or junction diode?

A diode is a single crystal of semiconducting material which is doped one side with a donor impurity and the other side with acceptor impurity.

22. What is a p-n junction?

The junction that is obtained when a p-type semiconductor and an n-type semiconductor are kept in contact is called p-n junction.

23. What is meant by junction potential?

The potential difference that is established due to the diffusion of electrons and holes across the boundary in the p-n junction is called junction voltage. The junction potential is 0.7v for Silicon and 0.3v for Germanium.

24. What is meant by depletion region?

The thin region around the junction containing immobile positive and negative charges is called depletion region.

25. When is a p-n junction said to be biased?

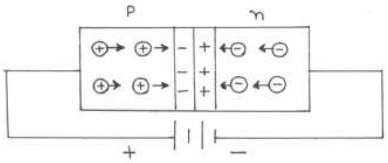
When an external source of e.m.f is connected to a p-n junction, it is said to be biased.

26. What is bias voltage?

The external voltage applied to make p-n junction biased is called bias voltage.

27. When is a p-n junction said to be forward biased or what is meant by forward biasing of p-n junction? How does it affect resistance?

When the positive terminal of a cell is connected to p-side and negative terminal to the n-side of a p-n junction then is said to be forward biased. It offers low resistance.

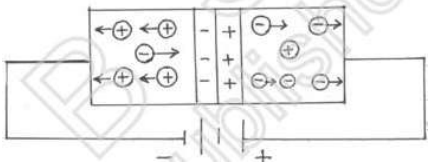


28. Why does a forward biased diode offer low resistance?

The external voltage over comes the junction potential and provides an easy path for the flow of charges across the junction. Hence it offers low resistance.

29. When is a p-n junction said to be reverse biased or what is meant by reverse biasing of p-n junction? How does it affect resistance?

When the positive terminal of a cell is connected to n-side and negative terminal to the p-side of a p-n junction then it is said to be reverse biased. It offers high resistance.



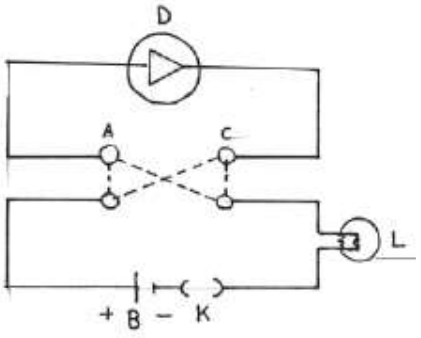
30. Why does a reversed biased diode offer high resistance?

The charge carriers are repelled from the junction and no current flows through the junction. Thus the diode offers a high resistance.

31. Why is there a small flow current during reverse bias?

In reverse bias there is a small flow of current due to minority charge carries electrons in p region and holes in n region.

32. In the circuit given along side D – diode, A – Anode, C – Cathode, B – Battery, K – Plug key, L- Lamp. Answer the following questions:



a) Does the lamp glow when the +ve terminal of battery is connected to A and –ve terminal is connected to C

The lamp glows as it is forward biased.

b) Does the lamp glow when the +ve terminal of battery is connected to C and –ve terminal is connected to A

The lamp does not glow as it is reverse biased.

33. Distinguish between forward biasing and reverse biasing.

Forward biasing	Reverse biasing
The positive terminal of the battery is connected to p-side and negative terminal is connected to n-side of a p-n junction	The positive terminal of the battery is connected to n-side and negative terminal is connected to p-side of a p-n junction
It offers low resistance	It offers high resistance

34. What is a rectifier?

A rectifier is a device that allows current to pass through in one direction.

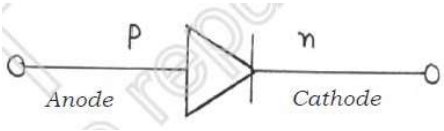
35. Why is a diode called as rectifier?

Diode allows current to pass only when it is forward biased when AC voltage is applied across a diode. This property is used to rectify AC voltage. Hence a diode is called as rectifier.

36. Name the types of rectifier.

The two types of rectifier are: a) Half wave rectifier b) Full wave rectifier.

37. Write the circuit symbol of a diode.



38. Mention the characteristics of a diode.

a) Diode has a p-type semiconductor at one end and a n-type semiconductor on the other end.
b) It can be biased by connecting to an external source of e.m.f
c) It may be forward biased or reverse biased.
d) It allows current to pass through in one direction only.

39. Mention the applications of a diode.

a) Diode is used to convert A.C into D.C.
b) They are used in voltage regulation systems.
c) They are used in logic circuits which are used in computers.

40. Mention the different types of diodes and one use of each.

a) Light Emitting Diode (LED): They are used in lighting, display units of electric and electronic devices.
b) Zener diode: It is used in voltage stabilizers.
c) Photodiode: It is used in light sensitive semiconductors.
d) Laser diode: It is used in fiber optical fibre communications.

41. What is a transistor? Name its three regions.

Transistor is the short form of transfer resistor. It is a device having three terminal semiconductor. A transistor has two ends regions called emitter and collector. The middle is called base.

42. Write the functions of the tree regions of a transistor.

a) Emitter: It is of moderate size and heavily doped. It emits large number of majority carriers for the flow of current through the transistor.

b) Base: It is the central region of the transistor. It is very thin and lightly doped. It regulates the flow of charges from emitter to collector.

c) Collector: It is moderately doped and larger in size compared to emitter. It collects a major portion of majority carriers supplied by the emitter.

43. Name the types of transistor.

a) Bipolar Junction Transistor (BJT)
b) Field Effect Transistor (FET)
c) Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
d) Junction Effect Transistor (JET)

44. Write about the biasing of a transistor.

Emitter base junction is forward biased while collector base junction is reverse biased.

45. Write the principle of a transistor or amplifier.

A small change in the input signal (voltage) results a large change in the output signal (voltage).

46. Draw the circuit diagram of a npn transistor amplifier or common emitter amplifier.

47. Draw the circuit diagram of pnp transistor amplifier.

48. Distinguish between npn and pnp transistor.

npn Transistor	pnp transistor
It is formed by sandwiching one p-type region between two n-type regions	It is formed by sandwiching one n-type region between two p-type regions
The voltage between the Base and Emitter is positive at the Base and negative at the Emitter.	The voltage between the Base and Emitter is negative at the Base and positive at the Emitter

49. Mention the applications of transistor.

a) Transistor is used in amplifier.
b) It is used in oscillator.
c) It is used in switching circuits.

50. What is an oscillator?

Oscillator is a device to produce electric oscillations of a desired frequency.

51. What is meant by superconductivity?

The property by which certain materials show almost zero resistance at a very low temperature is called superconductivity.

Ex: The resistance of mercury drops abruptly to zero at 4.2K

52. What are superconductors? Give example.

The materials which show property of superconductivity are called superconductors.
Example: Mercury, oxide of compound of Lanthanum, Barium and copper.

53. What is critical temperature?

The temperature below which material becomes superconductor is called critical temperature.

54. What is the most important feature of a superconductor?

The most important feature of a superconductor is that once current is setup in a superconductor ring, it will continue indefinitely even if the battery connected is switched off.

55. Mention the uses of superconductors.

a) Superconductors are used in powerful electromagnets.
b) High temperature super conductors are used in microwave devices.
c) Superconductor magnets are used in Magnetic Resonance Imaging (MRI)

Fill in the blanks:

1. Silicon is a **14^{th}** group element.
2. Silicon has **4** valance electrons.
3. Pure semiconductors are **insulators** at **room temperature**.
4. When an electron is detached from the covalent bond, it creates a **hole/vacancy**.
5. A hole behaves as a **positive** charge.
6. The total current in the semiconductor is the sum of electric current due to **flow of electrons and the flow of holes**.
7. In a **pure/intrinsic** semiconductor the number of electrons and holes are always **equal**.
8. The impurities added to pure semiconductor to enhance the conductivity are called **dopants**.
9. Dopants are added to pure semiconductors to **enhance their conductivity**.
10. The process of adding impurities to a pure semiconductor is called **doping**.
11. An n-type semiconductor is formed by adding **pentavalent** impurity.
12. An example of a pentavalent impurity is **arsenic/antimony/phosphorous**.

13. Pentavalent impurity is called **donor** impurity.
14. A p-type semiconductor is formed by adding **trivalent** impurity.
15. Trivalent impurity is called **acceptor** impurity.
16. An example of a trivalent impurity is **boron/indium/gallium/aluminium**.
17. In an n-type semiconductor majority charge carriers are **electrons**.
18. In a p-type semiconductor majority charge carriers are **holes**.
19. A single crystal of semiconducting material which is doped one side with a donor impurity and the other side with acceptor impurity is called p-n junction or semiconductor diode.
20. The junction potential is **0.7v** for Silicon.
21. The junction potential is **0.3v** for Germanium.
22. The thin region around the junction containing immobile positive and negative charges is called **depletion region**.
23. The process of connecting an external source of e.m.f to a p-n junction is called **biasing**.
24. The external voltage applied to make p-n junction biased is called **bias voltage**.
25. A forward biased p-n junction offers **low resistance**.
26. A reversed biased p-n junction offers **high resistance**.
27. P-N junction diode allows current to pass in **one direction only**.
28. A device which allows current to pass in one direction only is called **rectifier**.
29. The arrow mark in the circuit symbol of a diode represents **conventional flow of current**.
30. The electronic component used to convert A.C. to D.C. is **diode**.
31. The electronic component used in voltage regulating system is **diode**.
32. The type of diode used in voltage stabilizers is **Zener diode**.
33. The type of diode used in display units of electric & electronic devices is **Light Emitting Diode**.
34. The short form of transfer resistor is **transistor**.
35. In a transistor, the region which is heavily doped is **emitter**.
36. In a transistor, the region which is lightly doped is **base**.
37. In a transistor, emitter-base junction is **forward** biased.
38. In a transistor, collector-base junction is **reverse** biased.
39. A small change in input signal of a transistor results in **a large change in output signal**.
40. The correct relation between current in emitter (I_E), current in base (I_B) and current in collector (I_C) is $\mathbf{I_E = I_B + I_C}$.
41. The device used to produce electric oscillations of desired frequency is called **oscillator**.
42. The property by which certain materials show almost zero resistance at a very low temperature is called **superconductivity**.
43. The resistance of mercury drops abruptly to zero at **4.2K**.
44. The material which shows property of superconductivity is called **superconductors**.
45. The temperature below which material becomes superconductor is called **critical temperature**.
46. The highest temperature at which a material behaves as superconductor is about **125K**.
47. The scientist from Indian Institute of Science, Bangalore who has done a remarkable work in the field of superconductivity is **Professor C.N.R.Rao**.

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