Q1. Which of the following materials has the highest electrical conductivity at room temperature?

A. Copper
B. Germanium
C. Silicon
D. Diamond

Answer: A. Copper
Explanation: Copper is a good conductor with very high free electron density. Germanium and silicon are semiconductors, while diamond is an insulator.

Q2. The energy gap of silicon at 300 K is approximately:

A. 0.7 eV
B. 1.1 eV
C. 2.3 eV
D. 5.5 eV

Answer: B. 1.1 eV
Explanation: Energy band gap for silicon = 1.1 eV, for germanium = 0.7 eV, for diamond = 5.5 eV.

Q3. When a p-type semiconductor is heated, the number of holes:

A. Increases
B. Decreases
C. Remains constant
D. First increases, then decreases

Answer: A. Increases
Explanation: Heating increases intrinsic carrier concentration. In p-type, holes are majority carriers, so their number increases.

Q4. The majority carriers in an n-type semiconductor are:

A. Electrons
B. Holes
C. Protons
D. Photons

Answer: A. Electrons
Explanation: In n-type semiconductors (pentavalent doping), electrons are majority carriers.

Q5. A forward biased pn junction diode has:

A. High resistance
B. Low resistance
C. Infinite resistance
D. Negative resistance

Answer: B. Low resistance
Explanation: In forward bias, barrier potential decreases, current flows easily.

Q6. Which of the following is true for an intrinsic semiconductor at 0 K?

A. Behaves as insulator
B. Acts like a metal
C. Infinite conductivity
D. Works as rectifier

Answer: A. Behaves as insulator
Explanation: No free carriers exist at 0 K, hence intrinsic semiconductor is insulator.

Q7. In a zener diode, reverse breakdown at low voltage is due to:

A. Avalanche effect
B. Quantum tunneling
C. Thermionic emission
D. Impact ionization

Answer: B. Quantum tunneling
Explanation: Zener breakdown occurs at low voltages due to tunneling through the depletion region.

Q8. The output of a half-wave rectifier contains:

A. Only DC
B. Only AC

C. DC + even harmonics of AC
D. DC + odd harmonics of AC

Answer: D. DC + odd harmonics of AC
Explanation: Half-wave rectifier output = DC component + odd harmonics of input.

Q9. In a full-wave rectifier, the ripple frequency is:

A. Same as input frequency
B. Double the input frequency
C. Half the input frequency
D. Zero

Answer: B. Double the input frequency
Explanation: In full-wave rectifier, current flows in both half-cycles → ripple frequency = 2f.

Q10. A photodiode is operated under:

A. Forward bias
B. Reverse bias
C. Zero bias
D. Both forward and reverse bias

Answer: B. Reverse bias
Explanation: Reverse bias widens depletion region; photons create e–h pairs generating photocurrent.

Q11. Which of the following logic gates gives a low output only when all inputs are high?

A. NAND gate
B. NOR gate
C. AND gate
D. OR gate

Answer: A. NAND gate
Explanation: NAND = NOT(AND). It gives 0 only if all inputs = 1.

Q12. The potential barrier of a silicon pn junction at room temperature is about:

A. 0.1 V
B. 0.3 V
C. 0.7 V
D. 1.1 V

Answer: C. 0.7 V
Explanation: For Si ≈ 0.7 V, for Ge ≈ 0.3 V.

Q13. A light emitting diode (LED) works on:

A. Blackbody radiation
B. Photoelectric effect
C. Electron–hole recombination with photon emission
D. Stimulated emission of light

Answer: C. Electron–hole recombination with photon emission
Explanation: Electrons recombine with holes in LED → photons emitted (visible light).

Q14. Which of the following semiconductors is most suitable for making LEDs?

A. Germanium
B. Silicon
C. Gallium arsenide
D. Diamond

Answer: C. Gallium arsenide
Explanation: LEDs are fabricated from direct band-gap semiconductors like GaAs, GaP.

Q15. In a half-wave rectifier, the frequency of ripple is:

A. Equal to input frequency
B. Twice the input frequency
C. Half the input frequency
D. Independent of input frequency

Answer: A. Equal to input frequency
Explanation: Ripple frequency of half-wave rectifier = f (same as input).

Q16. A copper wire of cross-sectional area 1 mm^2 carries a current of 3 A. If the number density of electrons is 8.5×10^{28} m^{-3} and electronic charge is 1.6×10^{-19} C, the drift velocity is approximately:

A. 2.2×10^{-5} m/s
B. 4.5×10^{-4} m/s
C. 2.2×10^{-4} m/s
D. 4.5×10^{-5} m/s

Answer: C. 2.2×10^{-4} m/s
Explanation: Drift velocity v = I / (n × A × e) = 3 / ($8.5 \times 10^{28} \times 1 \times 10^{-6} \times 1.6 \times 10^{-19}$) ≈ 2.2×10^{-4} m/s.

Q17. A current of 1.6 A flows through a silver wire of cross-sectional area 1 mm^2. If number density of electrons is 6×10^{28} m^{-3}, the drift velocity of electrons is:

A. 1.6×10^{-4} m/s
B. 1.67×10^{-4} m/s
C. 1.67×10^{-5} m/s
D. 1.6×10^{-5} m/s

Answer: B. 1.67×10^{-4} m/s
Explanation: Using v = I / (n × A × e), substitute values to get v ≈ 1.67×10^{-4} m/s.

Q18. A conductor of length 1 m has resistance 3 ohm. If mobility of electrons is 5×10^{-3} m^2/Vs and number density is 8×10^{28} m^{-3}, the resistivity of the material is:

A. 2.5×10^{-8} ohm m
B. 1.25×10^{-8} ohm m
C. 5×10^{-8} ohm m
D. 1×10^{-7} ohm m

Answer: A. 2.5×10^{-8} ohm m
Explanation: Resistivity ρ = 1 / (n × e × mobility). Substituting gives ρ ≈ 2.5×10^{-8} ohm m.

Q19. The mobility of charge carriers in a semiconductor is 0.4 m^2/Vs and conductivity is 160 S/m. If charge of an electron is 1.6×10^{-19} C, the number density of charge carriers is:

A. $2.5 \times 10^{21}\ m^{-3}$
B. $3 \times 10^{21}\ m^{-3}$
C. $2.5 \times 10^{22}\ m^{-3}$
D. $3 \times 10^{22}\ m^{-3}$

Answer: C. $2.5 \times 10^{22}\ m^{-3}$
Explanation: Conductivity $\sigma = n \times e \times$ mobility. $n = \sigma / (e \times \text{mobility}) = 160 / (1.6 \times 10^{-19} \times 0.4) \approx 2.5 \times 10^{22}\ m^{-3}$.

Q20. A silicon diode has barrier potential of 0.7 V. If it is forward biased with 5 V, the voltage across the diode is approximately:

A. 0.7 V
B. 4.3 V
C. 5 V
D. 4.7 V

Answer: A. 0.7 V
Explanation: In forward bias, diode maintains a nearly constant barrier voltage of 0.7 V for silicon.

Q21. An LED emits light at 620 nm. The energy of one photon is approximately:

A. 2.0 eV
B. 2.5 eV
C. 2.7 eV
D. 3.0 eV

Answer: B. 2.0 eV
Explanation: Energy = hc/λ = (1240 eV·nm) / 620 ≈ 2.0 eV.

Q22. A pn junction diode is forward biased with 2 V and has resistance of 20 ohm in forward bias. The current through the diode is:

A. 0.05 A
B. 0.1 A
C. 0.2 A
D. 0.4 A

Answer: B. 0.1 A

Explanation: Current $I = V/R = 2 / 20 = 0.1$ A.

Q23. The truth table of a logic gate is given: Input (0,0) → Output 0; Input (0,1) → Output 1; Input (1,0) → Output 1; Input (1,1) → Output 0. The logic gate is:

A. AND
B. OR
C. NAND
D. XOR

Answer: D. XOR
Explanation: XOR gate outputs 1 only when inputs are different.

Q24. The current in a wire is 3 A. If drift velocity is 2×10^{-4} m/s and cross-sectional area is 1 mm^2, the number density of electrons is:

A. $9.4 \times 10^{28}\ m^{-3}$
B. $6.25 \times 10^{28}\ m^{-3}$
C. $8 \times 10^{28}\ m^{-3}$
D. $1 \times 10^{29}\ m^{-3}$

Answer: B. $6.25 \times 10^{28}\ m^{-3}$
Explanation: $v = I / (n \times A \times e)$. Solving for n gives $\approx 6.25 \times 10^{28}\ m^{-3}$.

Q25. A semiconductor has conductivity of 3.2 S/m when electron density is $1 \times 10^{22}\ m^{-3}$. If charge of electron is 1.6×10^{-19} C, the mobility of electrons is:

A. 0.1 m^2/Vs
B. 0.2 m^2/Vs
C. 0.3 m^2/Vs
D. 0.4 m^2/Vs

Answer: B. 0.2 m^2/Vs
Explanation: Mobility $\mu = \sigma / (n \times e)$. Substituting values gives $\mu \approx 0.2\ m^2/Vs$.

Q26. A Zener diode is used in power supplies because it:

A. Works as a rectifier
B. Provides constant voltage
C. Increases current
D. Blocks reverse current completely

Answer: B. Provides constant voltage
Explanation: A Zener diode in reverse bias beyond breakdown maintains nearly constant output voltage, hence used as a voltage regulator.

Q27. The breakdown in a Zener diode is mainly due to:

A. Thermionic emission
B. Tunneling of charge carriers
C. Lattice vibrations
D. Impact ionization

Answer: B. Tunneling of charge carriers
Explanation: In Zener breakdown (low voltage), strong electric fields allow electrons to tunnel through the depletion region, leading to sharp increase in current.

Q28. Which of the following diodes is used for emitting light in optical communication?

A. Zener diode
B. Photodiode
C. LED
D. Rectifier diode

Answer: C. LED
Explanation: LEDs emit visible or infrared light when forward biased, making them useful in indicators and optical communication.

Q29. The efficiency of a solar cell is maximum when:

A. It is forward biased
B. It is reverse biased
C. It operates in equilibrium
D. Photogenerated carriers are collected quickly

Answer: D. Photogenerated carriers are collected quickly
Explanation: A solar cell works in equilibrium (no external bias). Efficiency improves when electron-hole pairs generated by sunlight are collected before recombination.

Q30. In a photodiode, the photocurrent is:

A. Directly proportional to intensity of incident light
B. Inversely proportional to intensity of incident light
C. Independent of light intensity
D. Maximum at zero bias

Answer: A. Directly proportional to intensity of incident light
Explanation: The number of electron-hole pairs generated depends on light intensity, hence photocurrent $\propto$ incident light intensity.

Q31. A light-emitting diode (LED) emits light when:

A. Reverse biased
B. Forward biased
C. At breakdown voltage
D. Heated strongly

Answer: B. Forward biased
Explanation: In forward bias, electrons recombine with holes at the junction, releasing energy as photons (light).

Q32. The reverse saturation current in a diode:

A. Increases with rise in temperature
B. Decreases with rise in temperature
C. Independent of temperature
D. Becomes zero at high temperature

Answer: A. Increases with rise in temperature
Explanation: With higher temperature, more electron-hole pairs are generated, hence reverse saturation current increases exponentially.

Q33. Which of the following is not true about a solar cell?

A. It is a p-n junction device
B. It works in forward bias
C. It converts solar energy into electrical energy
D. Its efficiency is less than 30%

Answer: B. It works in forward bias
Explanation: A solar cell is a p-n junction device that works in equilibrium (no bias). Options A, C, and D are correct, so B is false.

Q34. In Zener diode voltage regulation, when the load current increases suddenly, the current through Zener diode:

A. Increases
B. Decreases
C. Remains constant
D. First increases, then decreases

Answer: B. Decreases
Explanation: If load current increases, supply current remains same, hence current through Zener diode decreases to keep voltage constant.

Q35. The typical forward voltage drop across a silicon LED emitting visible light is about:

A. 0.2 V
B. 0.7 V
C. 1.8 – 3.0 V
D. 5.5 V

Answer: C. 1.8 – 3.0 V
Explanation: LEDs need higher forward voltage (depending on color). Red LEDs ~1.8 V, blue/white LEDs up to ~3 V.

Q36. The output (Y) of a circuit with inputs A and B connected to an OR gate and then to a NOT gate is equivalent to which logic gate?

A. AND
B. NAND

C. OR
D. NOR

Answer: D. NOR
Explanation: The circuit performs Y = (A + B)′, i.e., NOR operation.

Q37. The output (Y) of a circuit with inputs A and B connected to an AND gate and then to a NOT gate is equivalent to which logic gate?

A. AND
B. NAND
C. OR
D. NOR

Answer: B. NAND
Explanation: The circuit performs Y = (A·B)′, i.e., NAND operation.

Q38. The logic gate that gives high output (1) only when the two inputs are different is:

A. AND
B. XOR
C. NOR
D. NAND

Answer: B. XOR
Explanation: XOR gate outputs 1 if inputs differ.

Q39. A circuit produces Y = A′·B. This operation corresponds to which gate combination?

A. NAND
B. NOR
C. AND with one input inverted
D. OR

Answer: C. AND with one input inverted
Explanation: The circuit performs AND between B and the complement of A.

Q40. A circuit produces output Y = (A + B)·C. Which of the following expressions is correct for this circuit?

A. (A + B)·C
B. (A·B) + C
C. (A′ + B′)·C
D. (A + B + C)′

Answer: A. (A + B)·C
Explanation: The circuit ORs A and B, then ANDs the result with C.

Q41. A circuit has output Y = (A·B + A′·B′). Which logic function does it represent?

A. XOR
B. XNOR
C. NAND
D. NOR

Answer: B. XNOR
Explanation: The expression is the Boolean form of XNOR, which outputs 1 if inputs are equal.

Q42. The truth table showing output Y = (A + B)′ corresponds to which gate?

A. OR
B. NOR
C. NAND
D. XOR

Answer: B. NOR
Explanation: The given expression is the NOR operation.

Q43. Which of the following represents the Boolean expression of an XOR gate?

A. A′·B + A·B′
B. A·B + A′·B′
C. (A + B)′
D. (A·B)′

Answer: A. A′·B + A·B′

Explanation: XOR gate outputs 1 when inputs are different, represented by $A' \cdot B + A \cdot B'$.

Q44. Which gate is known as the "universal gate" because it can implement all other logic gates?

A. OR
B. AND
C. NAND
D. XOR

Answer: C. NAND
Explanation: NAND can be combined to form any other gate, hence called a universal gate.

Q45. If A = 1 and B = 0, the output of an XNOR gate will be:

A. 0
B. 1
C. Both 0 and 1
D. Cannot be determined

Answer: A. 0
Explanation: XNOR outputs 1 only when inputs are equal. Here, inputs differ, so output = 0.