Solid State Physics, Devices & Electronics – 20 MCQs with Detailed Solutions

JSSC CGL Technical (Physics) – Practice Set with Explanations

1) Bragg's law for X-ray diffraction from lattice planes is:

(a) $n\lambda = 2d\cos\theta$
(b) $n\lambda = 2d\sin\theta$
(c) $n\lambda = d\sin\theta$
(d) $n\lambda = d\cos\theta$
Correct Answer: (b)
Explanation: In a crystal, reflections from successive lattice planes separated by interplanar spacing d interfere constructively when the extra path $2d\sin\theta$ equals an integer multiple of the wavelength: $n\lambda = 2d\sin\theta$. This condition comes from setting phase difference = $2\pi n$.

2) Number of distinct Bravais lattices in 3D is:

(a) 7
(b) 14
(c) 21
(d) 32
Correct Answer: (b)
Explanation: There are 7 crystal systems (cubic, tetragonal, orthorhombic, hexagonal, rhombohedral, monoclinic, triclinic). Accounting for primitive/centered types gives 14 unique 3D Bravais lattices.

3) Which one is an amorphous solid?

(a) NaCl
(b) Glass
(c) Diamond
(d) Silicon
Correct Answer: (b)
Explanation: Amorphous solids lack long-range periodic order (random network), e.g., glass. NaCl, diamond, and crystalline silicon have long-range periodic lattices (crystalline).

4) A typical band gap of an insulator is:

(a) < 1 eV
(b) 1–3 eV
(c) > 5 eV
(d) 0 eV
Correct Answer: (c)
Explanation: Insulators have a large forbidden gap (Eg usually > 5 eV), semiconductors have small Eg (~0.5–3 eV), and metals effectively have $E_g \approx 0$ due to overlapping bands.

5) In an n-type semiconductor, the majority carriers are:

(a) Holes
(b) Electrons
(c) Electrons and holes equally
(d) Protons
Correct Answer: (b)
Explanation: n-type doping (donors) adds extra electrons to the conduction band $\rightarrow$ electrons are majority carriers, holes are minority.

6) Dulong–Petit law gives the molar heat capacity (Cv) of a crystalline solid (high T) as:

(a) 3R
(b) R
(c) 2R
(d) (3/2)R
Correct Answer: (a)
Explanation: Classically, each atom contributes 3 translational vibrational modes with energy kT per degree of freedom → per mole Cv ≈ 3R at high temperature (equipartition).

7) Low-temperature specific heat (Cv ∝ T^3) is explained by:

(a) Dulong–Petit Law
(b) Einstein Model
(c) Debye Model
(d) Joule's Law
Correct Answer: (c)
Explanation: Debye treated lattice vibrations as acoustic phonons with a cutoff (Debye frequency). Density of states ∝ ω^2 leads to Cv ∝ T^3 at low T, matching experiments.

8) Diamagnetic materials have magnetic susceptibility (χ):

(a) Small positive
(b) Small negative
(c) Very large positive
(d) Zero
Correct Answer: (b)
Explanation: Diamagnetism arises from Lenz-like induced currents opposing the applied field; χ is negative and very small in magnitude.

9) Expulsion of magnetic flux from a superconductor is called:

(a) Faraday Effect
(b) Meissner Effect
(c) Hall Effect
(d) Josephson Effect
Correct Answer: (b)
Explanation: Meissner effect: below Tc, a superconductor expels magnetic field (B→0 in bulk), showing it is a distinct thermodynamic phase, not merely a perfect conductor.

10) Current across a Josephson junction at zero voltage is carried by:

(a) Electrons
(b) Holes
(c) Cooper pairs
(d) Protons
Correct Answer: (c)
Explanation: Two superconductors separated by a thin barrier allow tunneling of paired electrons (Cooper pairs), giving a DC supercurrent I = Ic sinϕ at zero voltage; under DC voltage V, AC Josephson current with frequency 2eV/h appears.

11) A p–n junction diode is primarily used for:

(a) Amplification
(b) Rectification
(c) Oscillation

(d) Modulation
Correct Answer: (b)
Explanation: Forward bias → low resistance; reverse bias → high resistance. This asymmetric I–V enables AC→DC rectification.

12) A BJT used as an amplifier is biased to operate in the:

(a) Cut-off region
(b) Saturation region
(c) Active region
(d) Breakdown region
Correct Answer: (c)
Explanation: Active region (base–emitter forward biased, base–collector reverse biased) provides linear amplification of signals.

13) Which device is voltage-controlled?

(a) BJT
(b) FET/JFET
(c) Transformer
(d) Diode
Correct Answer: (b)
Explanation: In FETs, the channel conduction is controlled by gate–source voltage (VGS). BJTs are current-controlled (base current controls collector current).

14) The (amplitude) gain of an amplifier is:

(a) Input/Output
(b) Output/Input
(c) Input × Output
(d) Output – Input
Correct Answer: (b)
Explanation: Voltage (or current) gain Av = Vout/Vin (or Iout/Iin). Power gain = Pout/Pin. In decibels: G(dB) = 20 log10 Av (voltage/current) or 10 log10 (power).

15) Which gate is a universal gate?

(a) AND
(b) OR
(c) NAND
(d) XOR
Correct Answer: (c)
Explanation: NAND (and similarly NOR) is functionally complete: any logic function can be implemented using only NAND gates.

16) De Morgan's law states: overline(A · B) equals:

(a) A■ + B■
(b) A■ · B■
(c) A + B
(d) A · B
Correct Answer: (a)
Explanation: De Morgan's laws: overline(A · B) = A■ + B■ and overline(A + B) = A■ · B■. They follow from set/Boolean duality and truth tables.

17) XOR gate output is 1 when:

(a) Inputs are both 0
(b) Inputs are both 1
(c) Inputs are different
(d) Inputs are same
Correct Answer: (c)
Explanation: Exclusive-OR is ‘odd parity’: output 1 iff the number of 1’s among inputs is odd; for two inputs, it’s when inputs differ.

18) Which is NOT a secondary memory device?

(a) Hard Disk
(b) Pendrive
(c) RAM
(d) DVD
Correct Answer: (c)
Explanation: RAM is primary (volatile) memory; HDD, USB drives, and DVDs are non-volatile secondary storage.

19) The unit that performs arithmetic and logic operations in a microprocessor is:

(a) Control Unit
(b) ALU
(c) Register
(d) Memory
Correct Answer: (b)
Explanation: ALU (Arithmetic Logic Unit) executes operations like add, subtract, AND, OR, XOR, shifts. Control Unit sequences instructions; registers store operands; memory stores programs/data.

20) The room-temperature band gap of Silicon is closest to:

(a) 0 eV
(b) 1.1 eV
(c) 3.5 eV
(d) 5 eV
Correct Answer: (b)
Explanation: At 300 K, Silicon has Eg ≈ 1.12 eV. Germanium ≈ 0.66 eV; GaAs ≈ 1.42 eV; insulators have Eg > 5 eV.

Tip: Mark any questions you missed and revisit the corresponding concept in your revision sheet.