National Testing Agency

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Physics of Semiconductors and Devices

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Question Number : 1 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Wave vector of a photon with energy E in a medium of refractive index n is --------, where c is the speed of light in free space.

A. $\frac{\sqrt{n}E}{\hbar c}$

B. $\frac{E}{n\hbar c}$

C. $\frac{nE}{\hbar c}$

D. None of these

Options :

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

Question Number : 2 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a medium, the real and imaginary parts of the refractive index are n_o and k_o, respectively.

The real part of the dielectric constant of the medium is ----------.

A. $n_o^2 - k_o^2$

B. $k_o^2 - n_o^2$

C. $2k_o n_o$

D. None of these

Options :

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

Question Number : 3 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A direct band gap semiconductor, which has a band gap of E_g, is illuminated with a monochromatic light of photon energy E_{ph}. If the material has conduction and valence band effective masses of m_n and m_p, respectively, the magnitude of the k-vector for the valence band electrons, which take part in the direct transition to the conduction band, is ----------.

A. $\frac{1}{\hbar}\sqrt{2\left(E_{ph}-E_g\right)\left(\frac{1}{m_n}+\frac{1}{m_p}\right)^{-1}}$

B. $\frac{1}{\hbar}\sqrt{2\left(E_{ph}-E_g\right)\left(\frac{1}{m_n}-\frac{1}{m_p}\right)^{-1}}$

C. $\frac{1}{\hbar}\sqrt{\left(E_{ph}-E_g\right)\left(\frac{1}{m_n}+\frac{1}{m_p}\right)^{-1}}$

D. $\frac{1}{\hbar}\sqrt{\left(E_{ph}-E_g\right)\left(\frac{1}{m_n}-\frac{1}{m_p}\right)^{-1}}$

Options :

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

Question Number : 4 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For a direct band gap semiconductor of band gap E_g, the joint density of states for the photon energy E_{ph} greater than E_g is proportional to ----------.

A. $\left(E_{ph}-E_g\right)^2$

B. $\sqrt{E_{ph}-E_g}$

C. $E_{ph}-E_g$

D. None of these

Options :

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

Question Number : 5 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For a direct band gap semiconductor of band gap E_g, the absorption coefficient for the photon energy E_{ph} greater than E_g is proportional to ----------.

A. $\sqrt{E_{ph}-E_g}$

B. $\sqrt{1-\frac{E_g}{E_{ph}}}$

C. $\sqrt{E_{ph}^{-1}-E_g E_{ph}^{-2}}$

D. None of the above

Options :

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

Question Number : 6 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A semiconductor has two optical phonon branches with energies 25 and 50 meV. The density of phonons in the upper branch is ---------- times the density in the lower branch at a temperature T, for which the thermal energy $k_B T = 25$ meV.

A. $(e-1)/(e^2-1)$

B. $(e^2-1)/(e-1)$

C. $(e^2+1)/(e+1)$

D. $(e+1)/(e^2+1)$

Options :

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

Question Number : 7 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In an indirect band gap semiconductor with band gap of E_g, only one type of optical phonons with energy E_{pn} are involved in indirect transition processes. What is the ratio between the joint density of states for phonon absorption is to emission processes at a photon energy of E_{ph}?

A. $\left[(E_g-E_{ph}-E_{pn})/(E_g-E_{ph}+E_{pn})\right]^2$

B. $\left[(E_g-E_{ph}+E_{pn})/(E_g-E_{ph}-E_{pn})\right]^2$

C. $\left[(E_g-E_{ph}+E_{pn})/(E_g-E_{ph}-E_{pn})\right]$

D. $\left[(E_g-E_{ph}-E_{pn})/(E_g-E_{ph}+E_{pn})\right]$

Options :

1. A
2. B

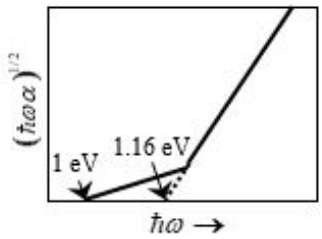
3. C

4. D

Question Number : 8 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

See the figure above, which shows a plot for the absorption coefficient α as a function of the photon energy $\hbar\omega$ at the band edge of a semiconductor. Which of the following statements is incorrect?



A. The semiconductor has an indirect band gap
B. Band gap is 1.08 eV
C. Two phonon modes are involved in the transition
D. Energy of the associated phonon is 80 meV

Options :

1. A

2. B

3. C

4. D

Question Number : 9 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In an indirect band gap semiconductor with band gap of E_g, only one type of phonons with energy E_{pn} are involved in indirect transition processes. What is the minimum photon energy above which any absorption can take place?

A. $E_g + E_{pn}$
B. $E_g - E_{pn}$
C. E_g
D. $E_g - 2E_{pn}$

Options :

1. A

2. B

3. C

4. D

Question Number : 10 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A direct band gap semiconductor has conduction and valence band effective masses of m_n and m_p, respectively. If a free exciton is constituted with a conduction band electron of wave vector $\vec{k}_n$ and a valence band hole with wave vector $\vec{k}_p$ the kinetic energy of the exciton is --- ----------.

A. $0.5\hbar^2(\vec{k}_n+\vec{k}_p)^2 m_n^{-1}$

B. $0.5\hbar^2(\vec{k}_n+\vec{k}_p)^2(m_n^{-1}+m_p^{-1})$

C. $0.5\hbar^2(\vec{k}_n+\vec{k}_p)^2(m_n+m_p)^{-1}$

D. $0.5\hbar^2(\vec{k}_n+\vec{k}_p)^2 m_p^{-1}$

Options :

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

Question Number : 11 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A direct band gap semiconductor has conduction and valence band effective masses of m_n and m_p, respectively. As far as the Bohr radius of the free exciton a_B^{ex} is concerned, which of the following statements is correct?

A. $a_B^{ex} \propto (m_n+m_p)^{-1}$

B. $a_B^{ex} \propto (m_n^{-1}+m_p^{-1})$

C. $a_B^{ex} \propto (m_n^{-1}+m_p^{-1})^{-1}$

D. $a_B^{ex} \propto (m_n+m_p)$

Options :

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

Question Number : 12 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A semiconductor has a lattice constant of a and exciton Bohr radius of a_B^{ex}. Which of the following conditions has to be satisfied for the formation of a Mott exciton in the system?

A. $a_B^{ex} \gg a$

B. $a_B^{ex} \ll a$

C. $a_B^{ex} = a$

D. $a_B^{ex} \approx a$

Options :

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

Question Number : 13 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a quantum well LED, the electron and hole blocking layers are used because

A. These layers block electrons and holes from reaching the active region and thus prevent radiative recombination
B. These layers help in light extraction from the LED
C. These layers lead to better confinement of carriers in the quantum well by preventing carrier loss and escape from the well
D. Without these layers, the LED cannot emit any light

Options :

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

Question Number : 14 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The turn-on voltage of an InGaN green LED will be

A. Less than the turn-on voltage of an InGaAs IR LED
B. More than the turn-on voltage of an AlGaN UV LED
C. Less than the turn-on voltage of a silicon p-n diode
D. More than the turn-on voltage of an InGaAs IR LED

Options :

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

Question Number : 15 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a silicon p-n junction, the p-side is very highly doped. In the neutral region of the n-side, the Fermi level is 0.2 eV below the conduction band. The built-in voltage for this junction will be approximately

A. 1.1 eV
B. 0.7 eV
C. 0.9 eV
D. 0.8 eV

Options :

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

Question Number : 16 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If the temperature of an LED is raised (i.e. it is heated), then

A. Its internal quantum efficiency will increase

B. Its internal quantum efficiency will decrease

C. Its internal quantum efficiency will become equal to external quantum efficiency

D. Its efficiency will remain unchanged

Options :

1. A

2. B

3. C

4. D

Question Number : 17 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The metal contacts to n- and p-type layers of an LED should be

A. Schottky type contacts so that excess voltage can be dropped across the contacts
B. Ohmic contacts with high contact resistance so that the efficiency of LED is high
C. Schottky contacts with very low reverse leakage
D. Ohmic contacts with as low contact resistance as possible

Options :

1. A

2. B

3. C

4. D

Question Number : 18 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the statements below about polarization in III-nitrides is correct?

A. Piezoelectric polarization always exists in all III-nitride semiconductors including bulk, thick layers
B. Piezoelectric and spontaneous polarization always point in the same direction
C. Piezoelectric polarization doesn't exist in perfectly lattice matched layers
D. It is polarization which enables InGaN LEDs to emit blue and green light

Options :

1. A

2. B

3. C

4. D

Question Number : 19 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A metal-semiconductor Schottky junction

A. Cannot be used as an LED
B. Can be used as an LED
C. Is always made using n-type semiconductor only
D. Cannot be used as a solar cell or photodetector

Options :

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

Question Number : 20 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

An InGaN green LED emitting at 540 nm has an EQE of 30% when biased at a forward voltage of 3.4 V. Its Wall Plug Efficiency (WPE) will be approximately

A. 20%
B. 30%
C. 40%
D. 10%

Options :

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

Question Number : 21 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

An InGaN LED

A. Emits blue if the Indium mole-fraction is more than the Gallium mole-fraction in the alloy
B. Cannot emit deep-UV wavelengths
C. Cannot emit red even if the indium mole fraction is adjusted accordingly
D. Has to be made only on GaN free-standing substrates

Options :

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

Question Number : 22 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The built-in potential of a Schottky diode is 1 V. The zero-bias capacitance of this diode is 400 nF/cm^2. At a reverse bias of -3 V, the capacitance of the diode will be:

A. 100 n nF/cm^2
B. 150 nF/cm^2
C. 200 nF/cm^2
D. 600 nF/cm^2

Options :

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

Question Number : 23 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Artificial lighting is important in our world today for several possible reasons, for example:

i. It allows us to work beyond the hours of natural daylight
ii. Electricity is cheaply available today
iii. It allows us to use indoor spaces without natural light
iv. Fossil fuels are depleting and hence we need to shift to renewable energy

Which of the above reasons are correct?

A. i)
B. i) ii)
C. i) and iii)
D. All of the options i) to iv)

Options :

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

Question Number : 24 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of these materials is NOT a compound semiconductor?

A. $Si_{0.95}Ge_{0.05}$
B. $YBa_2Cu_3O_{7-x}$
C. CdHgTe
D. $In_{0.1}Ga_{0.9}N$

Options :

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

Question Number : 25 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The band gap of aluminium gallium phosphide, AlGaP, depending on composition lies in the range of 2.26eV to 2.45eV corresponding to about 506 nm to 548 nm, in the green region of the visible spectrum. However the AlGaP material system is not used for making bright green LEDs because

A. The material has a monoclinic crystal structure making it difficult to work with
B. It has an indirect band gap
C. It is too expensive for a commercial technology to be based on it
D. All of the above

Options :

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

Question Number : 26 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

To make a GaN based p-n junction LED, the p-type dopant most commonly used is Magnesium. However, the doping levels are limited to only about 10^{17} cm^{-3} because

A. It is difficult to activate the Mg acceptor impurities in a wide bandgap semiconductor
B. Pre-reactions between the Mg precursor and the Ga precursor reduce the incorporation
C. The Mg-precursor has a higher vapour pressure and hence is easier to use than the Zn precursor
D. Some of the Mg atoms form Mg_3N_2 clusters in the GaN matrix

Options :

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

Question Number : 27 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Akasaki and Amano made a chance observation that enabled them to achieve p-type GaN and hence make a pn junction required for an LED. They obtained p-type conduction in Mg-doped GaN by:

A. Reflection high-energy electron diffraction (RHEED)
B. Femtosecond pulsed laser heating (FPLA)
C. High-angle annular dark field imaging (HAADF)
D. Low-energy electron-beam irradiation (LEEBI)

Options :

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

Question Number : 28 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

GaN is typically grown epitaxially on sapphire substrates. During the growth there is a 30° relative rotation of the unit cell of sapphire w.r.t that of GaN. The implications of this are:

A. The ~33% lattice mismatch between GaN and sapphire is reduced to ~ 14.8%, hence improving crystal quality
B. The formation of rotational twins hence deterioration of crystal quality
C. The interface layer between the GaN and sapphire changing from hexagonal to orthorhombic
D. Substitution of oxygen atoms at the sapphire surface by nitrogen atoms leading to a polycrystalline interface layer

Options :

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

Question Number : 29 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The substrate which has the same crystal symmetry as GaN is

A. Silicon (100)
B. 4H Silicon carbide (SiC)
C. β-Ga_2O_3 (-201)
D. GaAs (100)

Options :

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

Question Number : 30 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A key step in the epitaxial growth of GaN on sapphire is the two-step growth of the GaN - a buffer layer between the sapphire and the GaN, followed by the main GaN layer. In MOVPE growth, the layers are grown in which temperature ranges?

A. High temperature buffer (1000-1050 °C) followed by low temperature (520-550 °C) main layer
B. Both buffer and main layer grown at same temperature (1000-1050 °C), but with higher ammonia flow for buffer
C. Low temperature buffer (520-550 °C) followed by high temperature (1000-1050 °C) main layer
D. Both buffer and main layer grown at same temperature (1000-1050 °C), but with much lower reactor pressure for the buffer layer.

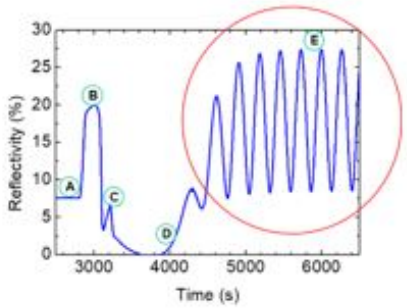
Options :

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

Question Number : 31 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The figure alongside shows the surface reflectivity measured in-situ during the growth of a GaN epitaxial layer using a 635nm laser. The oscillations in the circled part arise due to



A. Refractive index changes with temperature that change the reflectivity of the layer
B. Fabry-Perot oscillations due to interference between rays from the top surface of the GaN and the lower sapphire interface
C. Oscillations due to the alternating coverage of gallium and nitrogen atoms on the surface as the layers grow
D. Artefacts introduced due to the periodic rotation of the wafer

Options :

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

Question Number : 32 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Suppose a blue LED emitting at 410nm has $In_{0.08}Ga_{0.92}N$ quantum wells (InGaN with 8% indium) sandwiched between GaN barriers in its active region. If we want to make a similar structure that emits at 425 nm (longer wavelength) we should

A. Slightly decrease the amount of indium in the InGaN quantum well
B. Slightly increase the amount of indium in the InGaN quantum well
C. Add a small bit of aluminium to the InGaN quantum well layer
D. Add a small bit of aluminium to the GaN barrier layer

Options :

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

Question Number : 33 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For LED device fabrication, the GaN layers are usually etched in

A. Hot H_3PO_4/H_2O_2/DI water (8:1:1) mixture at 85 °C
B. Piranha etchant at room temperature
C. Reactive ion etching in Cl_2 or BCl_3 plasmas
D. Reactive ion etching in O_2/Ar plasma

Options :

1. A

2. B

3. C

4. D

Question Number : 34 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A quantitative measure of the ability of a light source to reveal the colours of various objects faithfully in comparison with an ideal or natural light source is called its

A. Chromaticity
B. Colour saturation
C. Efficiency
D. Colour rendering index

Options :

1. A

2. B

3. C

4. D

Question Number : 35 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Bravais lattice is an array of points with arrangement that (chose the one with the most number of correct answers):

A. Appears the same from whichever lattice point it is viewed.
B. Appears the same in some directions but not in others.
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

1. A

2. B

3. C

4. D

Question Number : 36 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

How many Bravais lattice points do primitive lattice vectors have in the volume they enclose?

A. 0
B. 1
C. 2
D. ∞

Options :

1. A

2. B

3. C

4. D

Question Number : 37 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is true (choose the one with the most number of correct answers):

A. Wigner-Sietz cell is a primitive cell.
B. Wigner-Sietz cell can only be defined in real space.
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

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

Question Number : 38 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Crystal structure is defined as:

A. Bravais lattice.
B. Basis.
C. Bravais Lattice + basis.
D. None of the above.

Options :

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

Question Number : 39 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For a set of points, $\{\vec{R}\}$, constituting a Bravais lattice, which of the following statements is true:

A. $e^{i\vec{k}.\vec{R}} = 1$ for all wavevectors $\vec{k}$.
B. $e^{i\vec{G}.\vec{R}} = 1$ for all reciprocal lattice vectors $\vec{G}$
C. $e^{i\vec{k}.\vec{R}} = 0$ for all wavevectors $\vec{k}$.
D. $e^{i\vec{G}.\vec{R}} = 0$ for all reciprocal lattice vectors $\vec{G}$.

Options :

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

Question Number : 40 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is true (chose the one with the largest number of correct answers):

A. Reciprocal lattice is a Bravais lattice.
B. For primitive vectors of the reciprocal lattice, $\vec{b_i}$ and primitive lattice vectors, $\vec{b_j}.\vec{a_i} = 0$
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

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

Question Number : 41 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. Energy of a free particle is given by its:

A. Potential Energy.
B. Kinetic Energy.
C. Neither (A) nor (B).
D. Energy of a free particle is 0.

Options :

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

Question Number : 42 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. In the free electron or Sommerfeld model, electrons are assumed to be

A. Interacting and follow Bose-Einstein statistics.
B. Interacting and follow Fermi-Dirac statistics.
C. Non-interacting and follow Bose-Einstein statistics.
D. Non-interacting and follow Fermi-Dirac statistics.

Options :

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

Question Number : 43 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

At temperature T= 0K, in the ground state of the free electron or Sommerfeld model:

A. All states below the Fermi Energy are empty and all states above the Fermi Energy are occupied.
B. Some states below the Fermi Energy are empty and some states above the Fermi Energy are occupied.
C. All states above the Fermi Energy are empty and all states below the Fermi Energy are occupied.
D. All states are empty and none of the states are occupied.

Options :

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

Question Number : 44 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For a one-dimensional crystal with lattice spacing a and size of the crystal N * a, according to Bloch's theorem, the period of the wave-function at all $\vec{k}$ -points and the period of the charge density are:

A. a and a.
B. a and N * a.
C. N * a and a.
D. N * a and N * a.

Options :

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

Question Number : 45 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For a solid with 6 electrons per primitive unit cell, using the Bloch's theorem, the Schrodinger equation of the electron is to be solved in a single primitive cell:

A. at only one $\vec{k}$-point for lowest eigenvalue.
B. at several $\vec{k}$-points for lowest eigenvalue.
C. at only one $\vec{k}$-point for multiple eigenvalues.
D. at several $\vec{k}$-points for multiple eigenvalues.

Options :

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

Question Number : 46 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

For $\vec{k}$ outside the first Brillouin zone, the solutions $\psi_{n,\vec{k}}(\vec{r})$ and $\epsilon_{n,\vec{k}}$

A. are not well defined.

B. are well defined and equal to $\psi_{n,\vec{k}+\vec{G}}(\vec{r})$ and $\epsilon_{n,\vec{k}+\vec{G}}$ where $\vec{G}$ is reciprocal lattice vector such that $\vec{k}+\vec{G}$ is in the first Brillouin zone.

C. are well defined but NOT equal to $\psi_{n,\vec{k}+\vec{G}}(\vec{r})$ and $\epsilon_{n,\vec{k}+\vec{G}}$ where $\vec{G}$ is the reciprocal lattice vector such that $\vec{k}+\vec{G}$ is in the first Brillouin zone.

D. None of the above.

Options :

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

Question Number : 47 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Intrinsic carrier density of GaAs at 300K is 2 x 10^6/cm^3. Given that in GaAs electron mobility μ_n = 8000 cm^2/V-sec and hole mobility μ_p = 400 cm^2/Vsec, what is the resistivity ρ in ohm-cm of intrinsic GaAs at 300K? Choose the option with value close to your calculation.

A. 4 x 10^6

B. 4 x 10^7

C. 4 x 10^8

Options :

1. A
2. B
3. C

Question Number : 48 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A wafer of silicon has concentration 10^{15}/cm^3 of phosphorus donors and 10^{16}/cm^3 of boron acceptors. Assume all donors and acceptors are ionized at 300 K. What is the concentration of electrons in units of per cm^3 in the wafer at 300 K? It is given that silicon has intrinsic carrier concentration n_i= 10^{10}/cm^3 at 300 K. Choose the option with value close to your calculation

A. 1x10^{15}

B. 1x10^{10}

C. 1x10^4

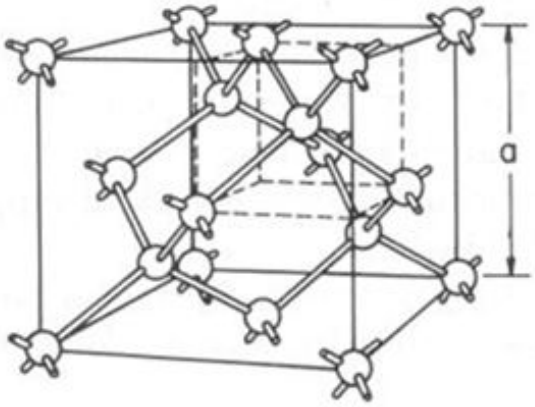
Options :

1. A
2. B
3. C

Question Number : 49 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Figure below shows typical unit cell of silicon crystal.



Given the side of silicon cube a = 5.43 A, what is the density of total number of electrons in the valence band of silicon in units of per cm^3?

A. $5x10^{22}$

B. $1x10^{23}$

C. $2x10^{23}$

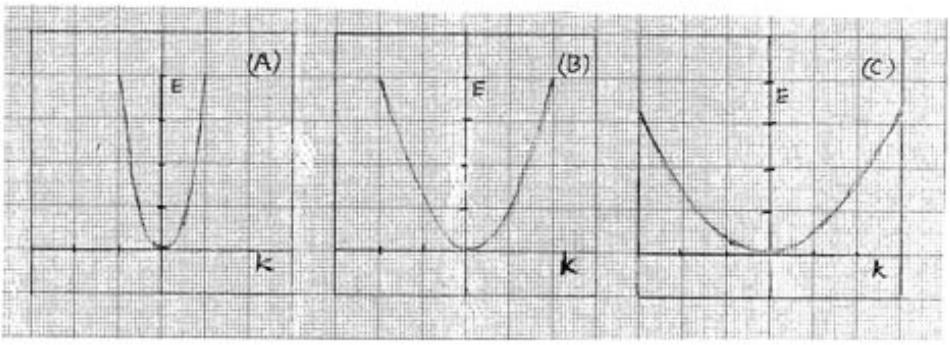
Options :

1. A
2. B
3. C

Question Number : 50 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Shown below are schematic E-k diagrams of conduction band of three different semiconductors A, B and C. Consider all the semiconductors are of high purity. Which semiconductor will have the lowest density of states?



a. A

b. B

c. C

Options :

1. A
2. B

3. C

Question Number : 51 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The mobility μ_n of electrons in high purity silicon is 1400 cm^2/V-sec at 300K. The electron mass in conduction band of silicon is 0.26 m_0 where m_0 is the rest mass of the electron. What is the mean scattering time between collisions for electrons in silicon in units of psec? $m_0 = 9.1 \times 10^{-31}$ Kg. Choose the option close to your answer.

A. 0.4

B. 0.3

C. 0.2

Options :

1. A
2. B
3. C

Question Number : 52 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Given the band gap of $Ga_{1-x}In_xN$ is given $E_g(x) = 3.42 - 2.65\,x - x(1-x)\,2.4$ eV, what is the composition of semiconductor (in atom fraction x) required to make light emitter at 0.45 micron? Relation between light wavelength λ and photon energy is $E_{photon} = 1.24 / \lambda$ (micron). Choose the option close to your answer.

A. 0.07

B. 0.10

C. 0. 14

Options :

1. A
2. B
3. C

Question Number : 53 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Photodiodes used for optical fibre communication are made from $In_xGa_{1-x}As$ lattice matched to InP. Lattice parameters of InAs, GaAs and InP are as follows: $a_{InAs} = 6.058$ A, $a_{GaAs} = 5.653$ A , $a_{InP} = 5.868$ A. Find x in the composition of $In_xGa_{1-x}As$ which is lattice matched to InP. Choose the option close to your answer.

A. 0.33

B. 0.43

C. 0.53

D. 0.63

Options :

1. A
2. B
3. C

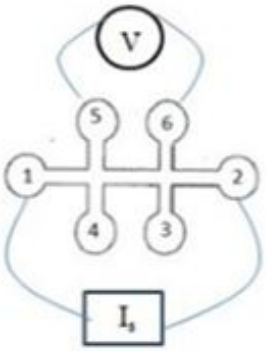
4. D

Question Number : 54 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

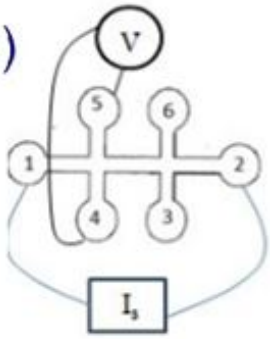
Correct Marks : 1 Wrong Marks : 0

A 10 micron thick layer of epitaxial GaAs is grown on a semi-insulating GaAs substrate. The sample is shaped into Hall Bar as shown below. The distance between the contacts numbered 5 and 6, L, is 0.5 cm and width of the sample is 0.1 cm. When 10^{-5} A current is passed through the Hall bar from terminals 1 to 2, voltage V_L = 50 mV is measured between the terminals 5 and 6 along the sample length. At B=0, voltage between terminals 4 and 5 is zero. At applied magnetic field 0.5 Wb/m^2, Hall voltage V_H= 3 mV is measured between contacts 4 and 5. Find the carrier density per cm^3. Choose the option close to your value.

a)



b)



A. 5×10^{14}

B. 1×10^{15}

C. 5×10^{15}

Options :

1. A

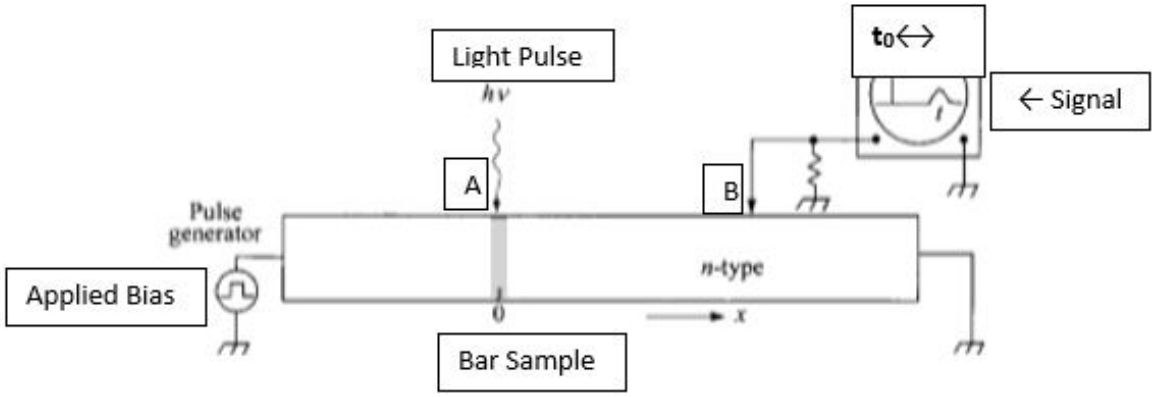
2. B

3. C

Question Number : 55 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Figure below shows an experiment to measure the drift mobility of carriers. A narrow pulse (of about 1 μsec duration) of minority carriers (holes in this case) is injected by light at point A of n-type Si bar sample. Holes drift towards point B in applied field and are collected at B and seen as broadened pulse signal. Distance L between points A and B is about 0.8 cm and the field applied is 7V/cm. The time t_0 between the application of hole injection at A and arrival of holes at B is 240 μsec. What is the drift mobility of holes in $cm^2/V\text{-}sec$? Choose the option close to your result.



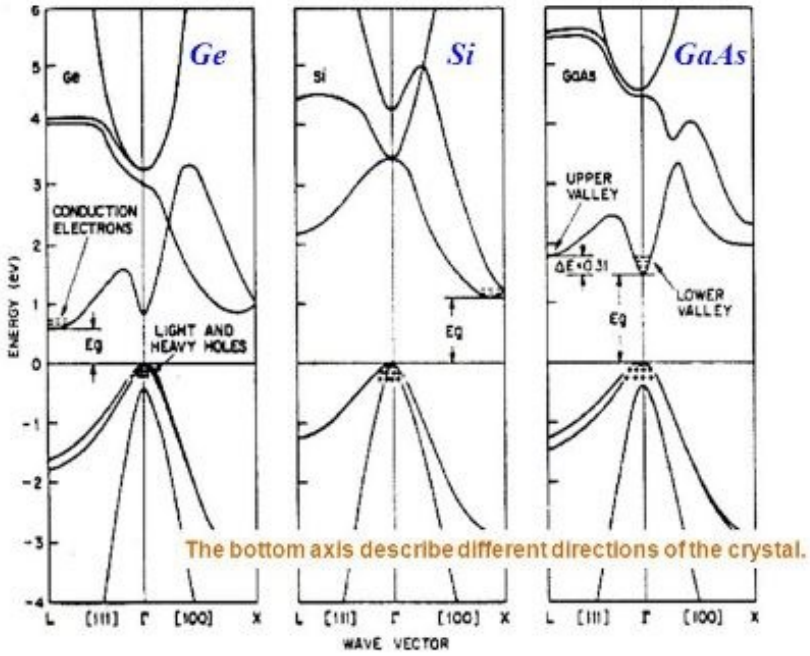
A. 400
B. 475
C. 550

Options :

1. A
2. B
3. C

Question Number : 56 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0



Shown above are the band diagrams for Ge, Si and GaAs. The number of valleys that exist at the conduction band minimum is

A. 1 for all of them
B. 1 for GaAs and 6 each for Si and Ge
C. 1 for GaAs, 6 for Si and 8 for Ge
D. 1 for GaAs, 6 for Ge and 8 for Si

Options :

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

Question Number : 57 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

E-k relation near the bottom of conduction band of silicon is given as $E = \hbar^2 (kx2 + k_y^2) /2\, m_t^* + \hbar^2 k_z^2/2m_l^*$, where m_t^* is the effective mass in direction transverse to k_z and m_l^* is effective mass in direction along k_z. The effective mass of electrons for calculating the density of states in conduction band assuming that the number of valleys are to be accounted separately is

A. $(2m_t^* + m_l^*)/3$
B. $[(m_t^*)^2.\ m_l^*]^{1/3}$
C. $(m_t^*.m_l)^{½}$
D. $[(ml^*)^2.\ mt^*]^{1/3}$

Options :

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

Question Number : 58 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Separation between exciton energy levels ---------- as one moves from the ground to higher order excited states.

A. first increases then decreases
B. decreases
C. does not change
D. increases

Options :

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

Question Number : 59 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Photoluminescence spectrum of a semiconductor shows a sub bandgap peak that moves to higher energies as the intensity of the excitation increases. One may conclude that the feature is associated with ----------.

A. donor-acceptor pair recombination
B. exciton recombination
C. band to impurity recombination
D. band to band recombination

Options :

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

Question Number : 60 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements regarding free exciton transition is correct?

A. Luminescence peak shifts to higher energy as temperature increases
B. Absorption peak appears at lower energy than the luminescence peak
C. Absorption and luminescence features appear below the bandgap
D. Intensity of the luminescence feature hardly changes with temperature

Options :

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

Question Number : 61 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

How many holes and electrons are bound in a neutral acceptor bound exciton?

A. 1 hole and 1 electron
B. 2 holes and 1 electron
C. 1 hole and 2 electrons
D. 2 holes and 2 electrons

Options :

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

Question Number : 62 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Photoluminescence (PL) intensity of a bound excitonic feature ---------- with the increase in temperature T.

A. increases
B. decreases
C. does not change
D. only in certain cases decreases

Options :

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

Question Number : 63 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The internal quantum efficiency of a blue LED depends on

A. The parasitic capacitances in the circuit
B. The contact resistances of the p- and n-contacts
C. Non-radiative recombination lifetime in the active layer
D. The packaging and light extracting approaches

Options :

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

Question Number : 64 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Indirect band gap semiconductors such as silicon

A. Can be used to make solar cells and LEDs
B. Can be used to make solar cells but not photodetectors
C. Can be used to make only LEDs but not solar cells and detectors
D. Can be used to make solar cells and detectors but not LEDs

Options :

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

Question Number : 65 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is correct for III-nitrides?

A. III-nitrides exist in wurtzite phase only, and hence, they are always polar
B. InGaN exhibits strong tensile stress when grown on GaN substrates
C. InAlN can be grown lattice matched to GaN by choosing appropriate Indium mole-fraction
D. AlGaN Quantum wells are sandwiched between p- and n-GaN layers to enable UV LEDs

Options :

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

Question Number : 66 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Quantum Confined Stark Effect (QCSE) is

A. Increase of emission intensity in an LED under the application of a field
B. Shifting of emission in a QW LED to longer wavelengths under the application of electric field or bias
C. Emission of wavelengths at discrete levels in a QW LED due to the formation of sub-bands
D. Splitting of emission wavelengths in a QW LED under magnetic field

Options :

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

Question Number : 67 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The reduction of efficiency of light emission on increasing current density an LED is called

A. Thermal rollover
B. Droop
C. Aging
D. Voltage slew

Options :

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

Question Number : 68 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Ohmic contacts to p-type GaN are more difficult than for n-type GaN because

A. The Mg dopant of the p-GaN forms complexes with the contact metal on alloying
B. The Schottky barrier height for most metals on p:GaN is much larger than for n:GaN
C. The Schottky barrier height for most metals on p:GaN is much lower than for n:GaN
D. The rapid thermal annealing step to form the contact degrades the p-GaN layer

Options :

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

Question Number : 69 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The UV-A region of the spectrum lies between

A. 140-200 nm
B. 200-280 nm
C. 280-320 nm
D. 320-400 nm

Options :

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

Question Number : 70 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The two kinds of polarization fields present in a GaN layer on sapphire are

A. Spontaneous polarization and piezoelectric polarization
B. Spontaneous polarization and pryoelectric polarization
C. Piezoelectric polarization and induced dipole polarization
D. Linear polarization and circular polarization

Options :

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

Question Number : 71 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The most popular way to make a "White" LED which is used for large scale production is

A. A UV LED with red, blue and green phosphors
B. A blue LED with a yellow phosphor
C. A Yellow LED with a blue phosphor
D. Use a red, blue and green LEDs in a common chip

Options :

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

Question Number : 72 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The main advantage of the epoxy dome on top of an LED chip from the point of view of optical efficiency is:

A. The refractive index of the epoxy is between that of the semiconductor and air hence it improves light extraction
B. There is no effect on efficiency since the purpose of the epoxy is to prevent oxygen and water vapour from reaching the chip
C. The epoxy is an electrical insulator and hence reduces leakage currents
D. The epoxy absorbs the unwanted wavelengths emitted by the LED

Options :

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

Question Number : 73 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Compared to a cool-white LED, a warm-white LED has

A. A phosphor with emission that is comparatively more blue-shifted
B. A phosphor with emission that is red-shifted than that of the cool-white LED
C. A phosphor with a longer radiative lifetime than that of the cool-white LED
D. A phosphor with a better quantum efficiency than that of the cool-white LED

Options :

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

Question Number : 74 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. Materials with completely filled bands are:

A. Metals.
B. Semiconductors/Insulators.
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

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

Question Number : 75 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. Materials with partially filled bands are:

A. Metals.
B. Semiconductors/Insulators.
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

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

Question Number : 76 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

As far as photoluminescence experiment is concerned, which of the following statements is not correct?

A. Sample is excited with photons of energy greater than the band gap
B. Intensity of the emitted light is measured as a function of the photon energy
C. Monochromator is used to select the emitted photons with a particular energy
D. Sample is placed between the monochromator and the detector

Options :

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

Question Number : 77 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

As far as absorption experiment is concerned, which of the following statements is not correct?

A. Sample is placed between the monochromator and the detector
B. Sample is illuminated with lights of different photon energies
C. Intensity of the light transmitted through the sample is measured as a function of the photon energy
D. Intensity of the light transmitted through the sample sharply decreases as the photon energy goes below the band gap

Options :

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

Question Number : 78 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is correct for III-nitrides?

A. III-nitrides exist in quartzite phase only, and hence, they are always polar
B. InGaN exhibits strong tensile stress when grown on GaN substrates
C. InAlN can be grown lattice matched to GaN by choosing appropriate Indium mole-fraction
D. AlGaN Quantum wells are sandwiched between p- and n-GaN layers to enable UV LEDs

Options :

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

Question Number : 79 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Auger recombination is

A. a radiative recombination that enhances the IQE of LEDs
B. a two-particle non-radiative recombination process
C. important to consider when carrier concentrations are very low
D. a three-particle non-radiative recombination process

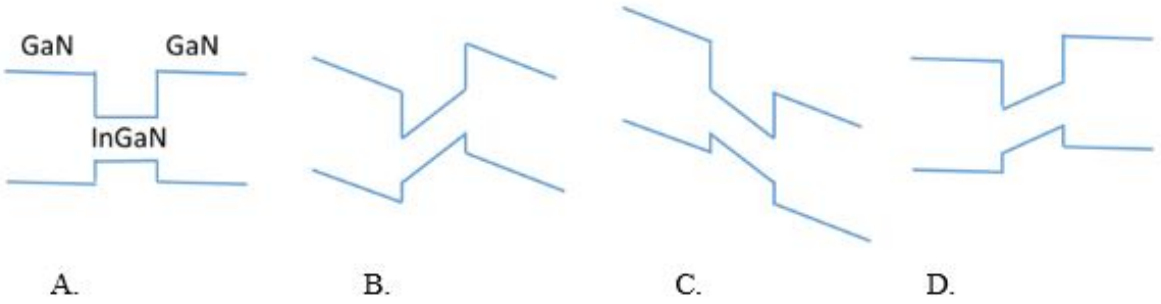
Options :

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

Question Number : 80 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The polarization field distorts the InGaN/GaN quantum wells grown on the "polar" c-plane. Which of these figures best represents the InGaN/GaN QW in a typical GaN LED under zero bias?



A. B. C. D.

Options :

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

Question Number : 81 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. The efficiency of UV LEDs across the UV wavelength range

A. Strongly decreases with decreasing emission wavelength across the UV region
B. Strongly Increases with decreasing emission wavelength across the UV region
C. Is independent of the wavelength range across the UV region as carrier leakage is constant
D. Is independent of the wavelength range across the UV region as carrier leakage compensates for increasing quantum well confinement

Options :

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

Question Number : 82 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

. The equivalent temperature of a blackbody with colour quality (chromaticity) nearest to that of the LED determines

A. The operating temperature of the active region at 350mA drive current
B. The maximum permissible operating temperature of the LED
C. The colour temperature of the LED
D. The temperature of the LED at which the emission spectrum matches the solar spectrum

Options :

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

Question Number : 83 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A weak periodic potential,

A. significantly changes the band structure at all $\vec{k}$-points.
B. significantly changes the band structure at all the $\vec{k}$-points where the free electron bands close in energy.
C. significantly changes the band structure only at the Brillouin zone edge
D. does not effect the band structure at all.

Options :

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

Question Number : 84 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In the semiclassical model of electron dynamics in the presence of an electric field for an electron in band, n, and with wave vector$\vec{k}$:

A. band index, n, and wave vector of the electron $\vec{k}$ do not change.
B. band index, n, changes but wave vector $\vec{k}$ does not change.
C. band index, n, does not change but wave vector $\vec{k}$ changes.
D. both band index, n, and wave vector $\vec{k}$ change.

Options :

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

Question Number : 85 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Electrical resistance in a solid arises due to scattering of electrons from:

A. periodic potential from the lattice.
B. non-periodic potential arising from defects/impurities.
C. Both (A) and (B).
D. Neither (A) nor (B).

Options :

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

Question Number : 86 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a constant magnetic field in and no electric field, the semiclassical equations of motion predict that electrons in a solid

A. will be stationary.
B. will move in circular motion confined to a plane.
C. will move in helical motion with axis of the helix along the direction of the field.
D. will move in unpredictable ways not given by any of the above.

Options :

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

Question Number : 87 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a constant electric field, the semiclassical equations of motion predict that electrons in a filled band in a solid

A. Do not move at all.
B. Every electron changes its wave vector by the same amount.
C. Pairs of electrons exchange their momentum.
D. Electron momentum changes in random ways.

Options :

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

Question Number : 88 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

According to simple band structure theory, semiconductors/insulators have (chose the one with the most number of correct answers):

A. Even number of electrons per unit cell.
B. Odd number of electrons per unit cell.
C. Both (A) and (B) are possible.
D. There are no semiconductors/insulators.

Options :

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

Question Number : 89 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is true:

A. Partially filled bands carry electrical and energy current.
B. Partially filled bands carry electrical current but no energy current.
C. Partially filled bands carry energy current but no electrical current.
D. Partially filled bands carry neither electrical nor energy current.

Options :

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

Question Number : 90 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is true about holes:

A. Holes have negative effective mass but positive charge.
B. Holes have negative effective mass and negative charge.
C. Holes have positive effective mass and positive charge.
D. Holes have positive effective mass but negative charge.

Options :

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

Question Number : 91 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Which of the following statements is true:

A. Electrons only carry electrical current and holes only carry energy current.
B. Electrons only carry energy current and holes only carry electrical current.
C. Neither electrons nor holes carry electrical current or energy current
D. Both electrons and holes carry electrical current and energy current.

Options :

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

Question Number : 92 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

The in-built electric polarization field in a GaN crystal

A. Is directed along the c-axis in the (0001) direction
B. Lies in the c-plane, directed along the (1-100) “m” direction
C. Lies in the c-plane, directed along the (11-20) “a” direction
D. None of the above

Options :

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

Question Number : 93 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A direct band gap n-type semiconductor is illuminated with an above band gap excitation. If the generation rate G is so, that at the steady state, excess electron concentration n_s is much larger than the background electron concentration. How n_s should vary as a function of G ?

A. $n_s \propto G$

B. $n_s \propto G^2$

C. $n_s \propto \sqrt{G}$

D. $n_s \propto G^{-1/2}$

Options :

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

Question Number : 94 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If the non-radiative lifetime is 1 μs and the radiative lifetime is 1 ns, then the IQE is approximately equal to

A. 0%
B. 1%
C. 100%
D. Undefined

Options :

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

Question Number : 95 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

A non-degenerate intrinsic direct band gap semiconductor has a band gap energy of E_g. The material is illuminated with an above band gap excitation. If it is considered that the recombination is taking place only via band-to-band radiative transition route, the peak of the transition at a temperature T should appear at an energy --------.

A. E_g

B. $E_g + 0.5k_BT$

C. $E_g + k_BT$

D. $E_g - 0.5k_BT$

Options :

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

Question Number : 96 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Photoluminescence spectrum of a direct band gap semiconductor shows an excitonic peak appearing at an energy E_x. The material has an optical phonon branch with energy E_{pn} that has a strong coupling with the excitons. Where is the 2nd phonon replica of the excitonic peak expected to appear?

A. $E_x - 2E_{pn}$

B. $E_x + 2E_{pn}$

C. $E_x - E_{pn}$

D. None of the above

Options :

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

Question Number : 97 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a p-n junction, the doping on the p-side is 10 times more than the doping on the n-side. At equilibrium, if the depletion towards the n-side is 150 nm, then the total depletion width is

A. 120 nm
B. 165 nm
C. 155 nm
D. 175 nm

Options :

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

Question Number : 98 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

Photoluminescence (PL) intensity I_{PL}^{xton} of an excitonic feature varies with the intensity of the photo excitation G as ----------.

A. $I_{PL}^{xton} \propto G$
B. $I_{PL}^{xton} \propto G^2$
C. $I_{PL}^{xton} \propto G^{-1}$
D. I_{PL}^{xton} is independent of G

Options :

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

Question Number : 99 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

If the doping in a silicon p-n junction is $N_D = N_A = 10^{16}$ cm^{-3}, then its built-in voltage is

A. 0.7 V
B. 0.8 V
C. 1 V
D. Undefined

Options :

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

Question Number : 100 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 1 Wrong Marks : 0

In a one-dimensional system, a weakly periodic potential with strength U, opens a gap of what magnitude at the edge of the Brillouin zone:

A. 0
B. $|U|$
C. $2|U|$
D. ∞

Options :

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