National Testing Agency

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Physics of Semiconductors and Devices

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Question Shuffling Allowed :	Yes

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

Consider a semiconductor film of thickness d_1 is grown on a substrate of thickness d_2. A beam of monochromatic light with intensity I_o falls on the sample surface vertically. A detector kept at the backside measures a transmitted intensity $0.5I_o$. If α_1 and α_2 are the absorption coefficients for the semiconductor layer and the substrate, respectively, which of the following statements is correct?

A. $\alpha_1 d_1 + \alpha_2 d_2 = \ln(2)$

B. $\alpha_1 d_1 + \alpha_2 d_2 = \ln(1/2)$

C. $\alpha_1 d_1 + \alpha_2 d_2 = 1/2$

D. None of these

Options :

1. 1
2. 2
3. 3
4. 4

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

The reverse saturation current in a p-n diode is 10 fA. What will be its ideality factor at a forward bias of 0.9 V if the forward current at that bias is 20 μA?

A. 1.6
B. 3.2
C. 2.1
D. 2.6

Options :

1. 1
2. 2
3. 3
4. 4

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

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

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

Options :

1. 1
2. 2
3. 3
4. 4

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 GaN (refractive index ≈ 2.56) the critical angle the GaN/air interface is 23°. Because of this:

A. Photons are selectively channelled into the sides and escape from the chip
B. The metal contact has to be aligned to cover the 23o cone at the centre of the chip to allow maximum current injection in this region
C. The internal efficiency is affected due to photon recycling
D. There is a narrow escape cone for light travelling from the semiconductor to air, causing low external quantum efficiency

Options :

1. 1
2. 2
3. 3
4. 4

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

A Bloch electron in an Eigen state characterized by band index, n, and wave vector $\vec{k}$,

A. Is stationary.
B. Starts with a velocity, $v_{n,\vec{k}} = \frac{2\pi}{h}\nabla_{\vec{k}}\epsilon_n(\vec{k})$ but stops after a while.
C. Starts with a velocity, $v_{n,\vec{k}} = \frac{2\pi}{h}\nabla_{\vec{k}}\epsilon_n(\vec{k})$ and continues forever without degradation.
D. Has a random velocity.

Options :

1. 1
2. 2
3. 3
4. 4

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 solar cell uses p type silicon which has resistivity 2 ohm-cm at 300K. Given the mobility of holes is 300 cm^2/V-sec, what is the doping concentration N_A in units of per cm^3? Assume there are no donors (N_D =0) and all acceptors are ionized at 300K ($N_A^- = N_A$). Choose the option with value close to your calculation.

A. 1×10^{16}

B. 5×10^{15}

C. 1×10^{15}

Options :

1. 1
2. 2
3. 3

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

A sample of GaN is doped p-type with Mg dopant with concentration $N_A = 10^{19}/cm^3$. It is given that donor concentration $N_D = 0$. Measurements show the hole concentration to be $10^{17}/cm^3$ at 300 K. Given that effective density of valence band states is $10^{19}/cm^3$ at 300 K, what is the ionization energy $E_A - E_V$ of the acceptors in units of eV? You may use the concentration of ionized acceptors to be given by $N_A^- = N_A / [1 + 4 \exp(E_A - E_F)/kT]$, where E_F is the Fermi energy .Tick a box closest to your estimate below.

A. 0.1

B. 0.2

C. 0.3

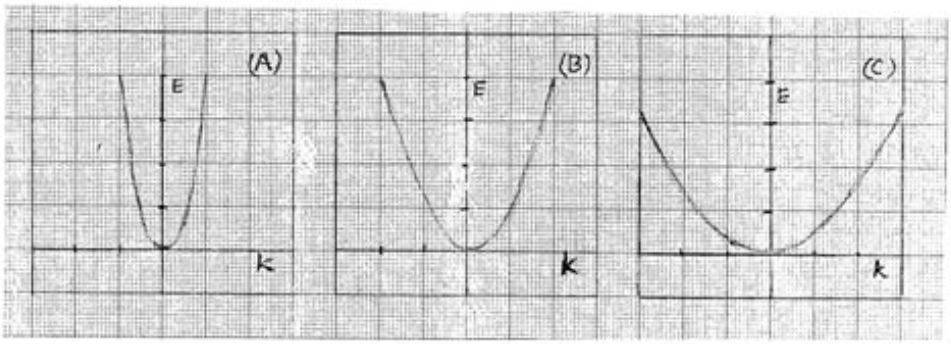
Options :

1. 1
2. 2
3. 3

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

Shown below are schematics of E-k diagrams of conduction band of three different semiconductors A, B and C. Consider all the semiconductors are high purity. Which semiconductor will have the highest density of states at a given energy?



a. A

b. B

c. C

Options :

1. 1
2. 2
3. 3

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

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 $0.26\, m_0$. Given, $m_0 = 9.1 \times 10^{-31}$ Kg. What is the Diffusion coefficient of electrons in high purity silicon at 300 K in units of cm^2/sec? Choose the option close to your answer.

A. 46.3

B. 36.3

C. 56.3

Options :

1. 1
2. 2
3. 3

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

Mobility of electrons in high purity silicon is 1400 cm^2/V-sec at 300K. This is the value limited by phonon scattering. Mobility of electrons doped with phosphorus donors at concentration $10^{18}/cm^3$ is 280 cm^2/V-sec at 300 K. What is the value of impurity scattering limited mobility at 300 K in units of cm^2/V-sec? Choose an option close to your estimate.

A. 550

B. 450

C. 350

Options :

1. 1
2. 2
3. 3

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

Band gaps of some semiconductors at 300 K are as follows: $E_{G,AlN} = 6.2$ eV, $EG_{,GaAs} = 1.42$ eV, $E_{G,Si} = 1.12$ eV, $EG_{,Al0.5Ga0.5N} = 4.5$ eV. Which of these is suitable for making a sun-blind (not sensitive to light of wavelength greater than 300 nm) detector of UV radiation of wavelength 256 nm?

A. AlN

B. GaAs

C. Si

D. $Al_{0.5}Ga_{0.5}N$

Options :

1. 1
2. 2
3. 3
4. 4

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

Band to band radiative recombination coefficient of silicon is $B = 10^{-15}$ cm^3/sec. A sample of p-type silicon has doping concentration $N_A = 10^{16}$ /cm^3. Excess electrons and holes are generated in the sample with light at concentration much smaller than N_A. The lifetime of non-radiative Shockley–Read–Hall (SRH) recombination τ_{NR} in this silicon sample is 100 µsec. What is the efficiency η of light emission? Choose the option close to your estimated value.

A. 10^{-2}

B. 10^{-3}

C. 10^{-4}

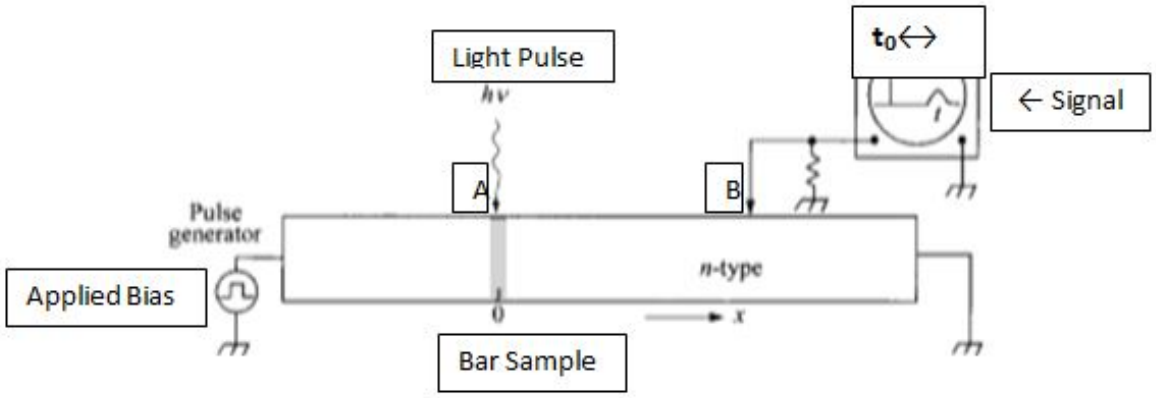
Options :

1. 1
2. 2
3. 3

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

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 velocity of holes in cm/sec? Choose the option close to your result.



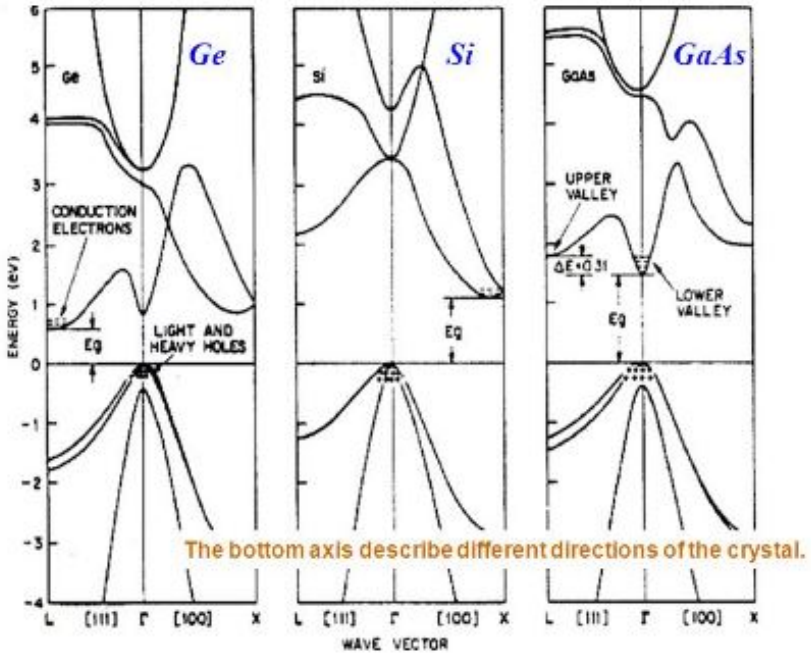
A. 3000
B. 3330
C. 3550

Options :

1. 1
2. 2
3. 3

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



Shown above are the band diagrams for Ge, Si and GaAs. Which of these is a direct band gap semiconductor?

A. Only GaAs
B. Si and Ge but no GaAs
C. Only Si
D. Only Ge

Options :

1. 1
2. 2
3. 3
4. 4

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

It is seen in the E-k diagram that the valence maximum consist of a heavy hole band for which the effective mass is m_{hh}* and a light hole band for which the effective mass is m_{lh}*. The effective mass of holes for calculating the density of states in the valence band is

A. $(m_{hh}^* + m_l)$
B. $[m_{hh}^* . m_{lh}^*]^{½}$
C. $[(m_{hh}^*)^{3/2} + (m_{lh}^*)^{3/2}]^{2/3}$
D. [(mhh*)^(2/3) + (mlh*)^(2/3)]^(3/2)

Options :

1. 1
2. 2
3. 3
4. 4

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

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. 1
2. 2
3. 3
4. 4

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

Which of these combinations is NOT a compound semiconductor?

A. $Al_{0.3}Ga_{1-x}As$
B. $YBa_2Cu_3O_{7-x}$
C. ZnMgSSe
D. $In_{0.1}Ga_{0.9}N$

Options :

1. 1
2. 2
3. 3
4. 4

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

The band gap of gallium phosphide, GaP, is 2.26eV corresponding to about 548 nm, in the green region of the visible spectrum. However, GaP 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. 1
2. 2
3. 3
4. 4

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

To make a GaN based p-n junction LED, the p-type dopant most commonly used is

A. Magnesium
B. Zinc
C. Silicon
D. Phosphorus

Options :

1. 1
2. 2
3. 3
4. 4

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

One of the contributions of Shuji Nakamura was the use of thermal annealing to activate the p-dopants in GaN. The thermal annealing step helped to:

A. Reduce the defects and improve the crystallinity of GaN
B. Redistribute the dopants in the p-type layer
C. Form nitrogen vacancies in the p-type layer
D. Remove hydrogen atoms that were passivating the acceptor impurities

Options :

1. 1
2. 2
3. 3
4. 4

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

GaN is typically grown epitaxially on sapphire substrates. The ~33% lattice mismatch between GaN and sapphire is reduced to ~ 14.8% primarily due to

A. A 30° relative rotation of the unit cell of sapphire w.r.t that of GaN
B. The relative change in lattice constant at the high growth temperature due to the different thermal expansion coefficients
C. The stable high temperature phase of GaN changing from hexagonal to orthorhombic
D. Substitution of oxygen atoms at the sapphire surface by nitrogen atoms

Options :

1. 1
2. 2
3. 3
4. 4

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 substrate with the least lattice mismatch to GaN is

A. Silicon (111)
B. Silicon carbide (SiC)
C. Sapphire
D. Silicon (100)

Options :

1. 1
2. 2
3. 3
4. 4

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

A key step in the epitaxial growth of GaN on sapphire is the growth of a buffer layer between the sapphire and the GaN. In MOVPE growth, the main GaN layer is usually grown at ~ 1000-1050 °C. The buffer layer is grown at

A. A temperature higher than that used for the main GaN layer (1100-1150 °C)
B. The same temperature as the main layer but with much higher ammonia flow
C. A lower temperature (520-550 °C)
D. The same temperature as the main layer but at a very low reactor pressure

Options :

1. 1
2. 2
3. 3
4. 4

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

For blue LEDs the active region consists of quantum wells of

A. InGaN, embedded in GaN barriers
B. GaN, embedded in AlGaN barriers
C. Si-doped AlGaN embedded in GaN barriers
D. Si-doped GaN embedded in InGaN barriers

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the metals would form a good Ohmic contact to n-type GaN?

A. Pt
B. Pd
C. Ti
D. Ni

Options :

1. 1
2. 2
3. 3
4. 4

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

Based on Schottky barrier heights, which metal would form a good Ohmic contact to p-type GaN?

A. Ti
B. Al
C. W
D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

The main difficulty in light extraction from a GaN-based LED is

A. The poor internal quantum efficiency of the active region
B. Blockage of light due to the metal contacts
C. Scattering due to rough interfaces and the top surface
D. A narrow escape cone for light due to the critical angle for light travelling from the semiconductor to air

Options :

1. 1
2. 2
3. 3
4. 4

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

The term efficiency droop in an LED refers to the

A. Reduction of efficiency of light emission due to increasing indium content in the quantum well
B. Reduction of efficiency of light emission on increasing current density
C. Reduction of efficiency of light emission due to aging of the device
D. Reduction of efficiency of light emission due to an increase in operating voltage

Options :

1. 1
2. 2
3. 3
4. 4

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 "green gap" problem in nitride LEDs refers to

A. Recombination at mid-gap defect states in GaN
B. Reduction of efficiency of light emission on increasing indium content in the quantum well when going from blue to green emitting LEDs
C. Environmentally friendly "green" LEDs being more expensive than the typical GaN LEDs
D. Poor performance of green-emitting LEDs due to absorption of green light in the sapphire substrate

Options :

1. 1
2. 2
3. 3
4. 4

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

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. 1
2. 2
3. 3
4. 4

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

Nanowire LEDs may solve several of the performance limiting issues in planar LEDs. Which of these statements are correct about NW LEDs? NW LEDs can i) Remove constraints of lattice matching, ii) expose non-polar and semi-polar facets, iii) make p-type doping easier iv) increase reflectivity of the contacts

A. i} and ii} only
B. i) and iii) only
C. ii), iii) and iv) only
D. All the statements i) to iv)

Options :

1. 1
2. 2
3. 3
4. 4

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

Ultraviolet LEDs may be more advantageous than mercury lamps for disinfection/water purification for which of the following reasons

A. The operating currents are lower, though the voltages needed are high
B. The operating temperature is lower
C. Large area devices can be made
D. The wavelength can be tuned to match the absorption peak of DNA in bacteria

Options :

1. 1
2. 2
3. 3
4. 4

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

The colour temperature of an LED is related to

A. The operating temperature of the active region at 350mA drive current
B. The increase in temperature of the LED between pulsed operation and continuous wave operation at a given wavelength
C. The equivalent temperature of a blackbody with colour quality (chromaticity) nearest to that of the LED
D. The operating temperature of the LED at which the emission spectrum matches that of a perfect blackbody

Options :

1. 1
2. 2
3. 3
4. 4

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

At equilibrium, a p-n junction has a built-in voltage of 1 V and a depletion width of 'W'. If a reverse bias of 8 V is applied on it, then the resultant depletion width is

a) Unchanged
b) W/8
c) 3W
d) 8W

Options :

1. 1
2. 2
3. 3
4. 4

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

Silicon has a band gap of 1.1 eV while GaAs has a band gap of 1.4 eV. Consider a p-n junction of silicon and GaAs separately, of identical dimensions and doping. Which of the following statements is correct?

a) Both Si and GaAs diodes will have the same reverse saturation current at a given voltage
b) Si will have higher reverse saturation current than GaAs at a given bias.
c) The net reverse current is given by reverse saturation current only
d) GaAs will emit light under reverse bias.

Options :

1. 1
2. 2
3. 3
4. 4

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

Consider the following statements

i. Silicon p-n junction can be used as a photo detector
ii. Silicon p-n junction can be used as an LED
iii. Silicon p-n junction can be used as a solar cell.

Now choose the correct options from below –

a) Statements i) and ii) are correct
b) Statements ii) and iii) are correct
c) Statements i) and iii) are correct
d) Only statement iii) is correct

Options :

1. 1
2. 2
3. 3
4. 4

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

A silicon p-n junction has a doping of $N_D = 10^{15}$ cm^{-3} on n-side and $N_A = 10^{18}$ cm^{-3} on the p-side. The total current under forward bias will be

a) Equally contributed by electrons injected from n-side and holes injected from p-side
b) Primarily contributed by holes injected from the p-side to the n-side
c) Primarily contributed by electrons injected from the n-side to the p-side
d) Independent of the doping on both sides

Options :

1. 1
2. 2
3. 3
4. 4

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

A silicon p-n junction has a doping of $N_D = 10^{16}$ cm^{-3} on n-side and $N_A = 10^{17}$ cm^{-3} on the p-side. At equilibrium, if the depletion towards the n-side is 100 nm, then the total depletion width for the junction will be

a) 110 nm
b) 1000 nm
c) 200 nm
d) The information provided is not sufficient to find the answer

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is correct for a p-n junction?

a) The built-in voltage at equilibrium can sometimes be greater than the band gap of the semiconductor
b) The built-in voltage for GaN p-n junction will be higher than that for a silicon p-n junction
c) The higher the built-in voltage, the higher is the reverse saturation current.
d) The equilibrium depletion width does not depend on the band gap of the semiconductor.

Options :

1. 1
2. 2
3. 3
4. 4

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

In a p-n junction, the doping on the p-side is 10 times more than the doping on the n-side. At equilibrium, the ratio of depletion width in the p-region to that in the n-region is given by,

A. 10
B. 100
C. 1
D. 0.1

Options :

1. 1
2. 2
3. 3
4. 4

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

A silicon p-n junction (X) has a doping of $N_D = N_A = 10^{15}$ cm^{-3} while another silicon p-n junction (Y) has a doping of $N_D = N_A = 10^{18}$ cm^{-3}. Which of the following is true?

a) Both X and Y have the same built-in voltage
b) X has a higher built-in voltage than Y
c) X has a lower built-in voltage than Y
d) The information provided is insufficient to comment.

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following is correct about a diode ideality factor?

a) Recombination dominated forward current will result in an ideality factor of 1
b) Ideality factor is defined for both forward and reverse bias currents
c) Ideality factor of a diode can never be more than 2
d) There is no ideality factor for reverse bias current.

Options :

1. 1
2. 2
3. 3
4. 4

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

If the temperature is raised for a p-n junction, then

a) Reverse saturation current will increase
b) Reverse saturation current doesn't change
c) Reverse saturation current will decrease
d) More information is needed to comment on reverse saturation current

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following is correct?

a) A blue LED has a larger turn-on voltage than a red LED

b) An LED is a purely monochromatic source of light

c) Commercial blue LEDs are made on free-standing GaN substrates

d) A GaN p-n junction can behave as a blue LED

Options :

1. 1
2. 2
3. 3
4. 4

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

A metal and a p-doped semiconductor will form a Schottky junction when

a) The metal work function is larger than the semiconductor work function

b) The metal and semiconductor have the same work function

c) The metal work function is lower than the semiconductor work function

d) A metal can never form a Schottky contact with p-type semiconductor

Options :

1. 1
2. 2
3. 3
4. 4

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

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

a) Polarization exists along the c-axis only

b) There are non-polar III-nitrides also

c) Polarization can be due to strain in the layers also

d) A thin layer of InGaN grown on thick GaN will have tensile stress.

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is true about internal quantum efficiency (IQE) of an LED?

a) IQE is higher if the radiative lifetime is much shorter than the non-radiative lifetime

b) IQE is higher if the radiative lifetime is much longer than the non-radiative lifetime

c) IQE does not depend on non-radiative lifetime

d) Auger recombination helps improve IQE

Options :

1. 1
2. 2

3. 3

4. 4

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

An InGaN blue LED emitting at 450 nm has an EQE of 50% when biased at a forward voltage of 4 V. Its Wall Plug Efficiency (WPE) will be approximately

a) 50%
b) 42%
c) 35%
d) 56%

Options :

1. 1

2. 2

3. 3

4. 4

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

A GaN near-UV LED emitting at 365 nm has an EQE of 50% when forward biased at 2 V. Which of the following statements is correct?

a) This is the maximum efficiency GaN LEDs can have

b) Its WPE will be 40%

c) Radiative and non-radiative recombination lifetimes are equal

d) A GaN LED cannot emit light at a forward bias of 2 V.

Options :

1. 1

2. 2

3. 3

4. 4

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

Consider the following statements on polarization in III-nitrides:

I. The piezo-electric polarization in InGaN quantum well arising out of compressive stress is in a direction opposite to the spontaneous polarization

II. The piezo-electric polarization in InGaN quantum well arising out of compressive stress is in the same direction as the spontaneous polarization

III. Piezoelectric polarization exists in all the layers in an InGaN LED, including n- and p-doped GaN layers

IV. Polarization results in a sheet of mobile negative charge (electrons) at the top of a layer and a sheet of mobile positive charge (holes) at the bottom interface.

Which of the following options is true?

a) Only statement (I) is correct
b) Only statement (II) is correct
c) Statements (I) and (IV) are correct
d) Statements (III) and (IV) are correct

Options :

1. 1
2. 2
3. 3
4. 4

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

For a semiconductor to emit light at wavelengthλ, its band gap should be equal to

A. hc/λ

B. $2hc/\lambda$

C. $hc/(2\lambda)$

D. $4hc/\lambda$

Options :

1. 1
2. 2
3. 3
4. 4

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

A light beam has a wavelength of 325 nm in free space. The energy of the light is

a) 381.5 eV
b) 0.3815 eV
c) 3.815 eV
d) 38.15 eV

Options :

1. 1
2. 2
3. 3
4. 4

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

A light beam has a photon energy of 2.541 eV. The wave vector of the light in free space is

a) $1.28 \times 10^{7}\ m^{-1}$

b) $1.28 \times 10^{6}\ m^{-1}$

c) $1.28 \times 10^{8}\ m^{-1}$

d) $1.28 \times 10^{5}\ m^{-1}$

Options :

1. 1
2. 2
3. 3
4. 4

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 p-n junction diode with intrinsic carrier density n_i has N_D concentration of donors in the n-type side and N_A concentration of acceptors in the p-type side. Its built-in voltage is proportional to,

A. $ln\frac{N_D n_i}{N_A^2}$

B. $ln\frac{N_A n_i}{N_D^2}$

C. $ln\frac{N_D N_A}{n_i^2}$

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

n-doped silicon sample is illuminated with weakly absorbed light such that the sample has a uniform generation rate of excess carriers G over its thickness d. What is the concentration of excess minority carriers given that the minority carrier lifetime is τ?

A. $G\,\tau^{1/2}$

B. $G\,\tau$

C. $G\,\tau^{2}$

D. $G\,\tau\,d$

Options :

1. 1
2. 2
3. 3
4. 4

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

Consider a non-degenerate intrinsic direct band gap semiconductor of band gap energy of E_g 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 ratio between the peak height of the transition and the integrated intensity of the feature at a temperature T should be

a) $\sqrt{\frac{1}{\pi}}2\exp(-0.5)$

b) $\sqrt{\frac{2}{\pi}}\exp(-0.5)$

c) $\sqrt{\frac{2}{\pi}}\exp(0.5)$

d) $\sqrt{\frac{1}{2\pi}}\exp(-0.5)$

Options :

1. 1
2. 2
3. 3
4. 4

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

Consider an n-type direct band gap semiconductor with shallow donor concentration of $1x10^{16}cm^{-3}$. The material is illuminated with an above band gap excitation at a generation rate of $1x10^{24}\ cm^{-3}s^{-1}$. The saturation hole concentration is found to be $1x10^{14}\ cm^{-3}$. If it is considered that the recombination is taking place only via band-to-band radiative transition route, the recombination lifetime for the holes is

a) 100 pico-sec
b) 0.1 pico-sec
c) 1000 pico-sec
d) 10 pico-sec

Options :

1. 1
2. 2
3. 3
4. 4

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

Consider a direct band gap semiconductor with a dielectric constant of 15.15 ε_0, where ε_0=8.85 $x10^{-12}$ F/m is the permittivity of the vacuum. The donor acceptor pair recombination peak shows a blue shift of 20 meV when the above-band-gap excitation intensity is increased by one order of magnitude. The change in the inverse of average donor-acceptor-pair separation is

a) $1.673 \times 10^5\ m^{-1}$
b) $1.673 \times 10^7\ m^{-1}$
c) 1 $1.673 \times 10^6\ m^{-1}$
d) $1.673 \times 10^8\ m^{-1}$

Options :

1. 1
2. 2
3. 3

4. 4

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

Consider a non-degenerate intrinsic direct band gap semiconductor of band gap energy of E_g and free exaction ground state energy of E_X is illuminated with an above band gap excitation. If at a temperature T, the free excitonic density of state distribution can be treated as a Gaussian with a standard deviation of $\sigma \sim k_B T$, the full width at half maximum (FWHM) of the free exaction transition feature is

a) Independent of T
b). 0.5 k_BT
c) 2.352 k_B T
d) 2 k_BT

Options :

1. 1
2. 2
3. 3
4. 4

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

GaN is a direct band gap semiconductor with the optical phonon energy of 90 meV. If the second phonon replica of the PL line for the free exaction transition appears at 3.298 eV, the zero phonon feature should have a peak at

a) 3.568 eV
b) 3.478 eV
c) 3.118 eV
d) 3.388 eV

Options :

1. 1
2. 2
3. 3
4. 4

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

In a direct band gap semiconductor with band gap energy of E_g, the zero phonon peaks for the free excitonic and neutral donor bound excitonic transitions are found to appear at E_x and E_{dox}, respectively. Which of the following statements is correct?

a) $E_g > E_{dox} > E_x$
b) $E_g > E_x > E_{dox}$
c) $E_g > E_{dox} = E_x$
d) $E_{dox} > E_g > E_x$

Options :

1. 1
2. 2
3. 3
4. 4

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

In a direct band gap semiconductor with band gap energy of E_g, the zero phonon peaks for the free excitonic and neutral acceptor bound excitonic transitions are found to appear at E_x and E_{aox}, respectively. Which of the following statements is correct?

a) $E_g > E_x > E_{aox}$

b) $E_g > E_{aox} > E_x$

c) $E_g > E_{aox} = E_x$

d) $E_{aox} > E_g > E_x$

Options :

1. 1
2. 2
3. 3
4. 4

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

In a direct band gap semiconductor with band gap energy of E_g, the zero phonon peaks for the neutral donor and neutral acceptor bound excitonic transitions are found to appear at E_{dox} and E_{aox}, respectively. Donor and acceptor activation energies are ΔE_d and ΔE_a, respectively. Which of the following statements is correct?

a) $E_{dox} > E_{aox}$ for $\Delta E_a > \Delta E_d$

b) $E_{dox} > E_{aox}$ for $\Delta E_a < \Delta E_d$

c) E_{dox}, E_{aox} independent of ΔE_a, ΔE_d

d) $E_{dox} = E_{aox}$ irrespective of ΔE_a, ΔE_d

Options :

1. 1
2. 2
3. 3
4. 4

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

Consider a direct band gap semiconductor with a donor concentration of N_d. The material is illuminated with an above band gap excitation at a generation rate of G. Consider that the recombination is taking place via only two channels; the band-to-band and the free excitonic transitions. If band-to-band recombination rate is considered to be much less than the free excitonic transition rate, the intensity of the free excitonic PL feature I_{FX} varies with the generation rate G as

a) I_{FX} independent of G

b) $I_{FX} \propto G^2$

c) $I_{FX} \propto \sqrt{G}$

d) $I_{FX} \propto G$

Options :

1. 1
2. 2
3. 3
4. 4

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 true?
(a) Wigner-Seitz cell has the full symmetry of the Bravais lattice
(b) All the points in the Wigner-Seitz cell about a lattice point are closer to that lattice point than any other lattice point
(c) Both (a) and (b)
(d) Neither (a) nor (b)

Options :

1. 1
2. 2
3. 3
4. 4

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

Crystal structure is defined as:
(a) Bravais lattice
(b) Basis
(c) Bravais Lattice + basis
(d) None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is true?
(a) Plane waves with any wave-vector have the periodicity of the Bravais lattice
(b) Plane waves with wave-vectors equal to reciprocal lattice vectors have the periodicity of the Bravais lattice
(c) Both (a) and (b)
(d) Neither (a) nor (b)

Options :

1. 1
2. 2
3. 3
4. 4

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

Three-dimensional periodic boundary conditions for the wavefunction, in a box of dimension, L are:
(a) $\psi(x,y,z) = \psi(x + L,y, z)$
(b) $\psi(x,y,z) = \psi(x, y + L,z)$
(c) $\psi(x, y,z) = \psi(x, y, z + L)$
(d) All of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

Energy of a free particle is given by its
(a) Potential energy
(b) Kinetic energy
(c) Neither (a) nor (b)
(d) 0

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements are true about the Summerfield model?
(a) A free particle can have any momentum but boundary conditions make the allowed momenta discrete.
(b) A free particle cannot have any momentum - its allowed momenta are discrete
(c) Momentum of a free particle is not well defined.
(d) None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

For a one-dimensional crystal with lattice spacing a the number of allowed eigenvalue/eigenvector electronic solutions at a general $\vec{k}$ point are:
(a) 0
(b) 1
(c) 2
(d) ∞

Options :

1. 1
2. 2
3. 3
4. 4

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 velocity of an electron at the edge of the Brillouin zone is:
(a) 0
(b) $2\pi e^2/h$
(c) $4\pi e^2/h$
(d) ∞

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is true?
(a) Filled bands carry electrical and energy current.
(b) Filled bands carry electrical current but no energy current.
(c) Filled bands carry energy current but no electrical current.
(d) Filled bands carry neither electrical nor energy current.

Options :

1. 1
2. 2
3. 3
4. 4

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

What is responsible for electrical resistance in a solid (chose the one with most number of correct possibilities):
(a) Defects
(b) Defects and Impurities
(c) Defects, Impurities and Phonons
(d) Defects, Impurities, Phonons and Ions

Options :

1. 1
2. 2
3. 3
4. 4

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

According the simple band structure theory, materials with even number of electrons Per unit cell can be:
(a) Metals
(b) Semiconductors/Insulators
(c) Both (a) or (b)
(d) Neither (a) nor (b)

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is true?
(a) For a given partially filled band, one can talk about current carried by electrons AND holes.
(b) For a given partially filled band, one can talk about current carried by electrons OR holes.
(c) Partially filled bands do not carry any current.
(d) None of the above.

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following statements is true about holes?
(a) Holes have positive effective mass and positive charge.
(b) Holes have positive effective mass but negative charge.
(c) Holes have negative effective mass but positive charge.
(d) Holes have negative effective mass and negative charge.

Options :

1. 1
2. 2
3. 3
4. 4

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

Bright red LEDs are fabricated from $(Al_xGa_{1-x})_{0.5In0.5P}$ with band gap given by $E_g(x) = 1.91 + 0.61x$ eV. The atom fraction, 0.5x, of Al in the semiconductor for emission at 0.62 micron is

(a) 0.065
(b) 0.07
(c) 0.074
(d) 0.08

Options :

1. 1

2. 2

3. 3

4. 4

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

Silicon solar cells use p type silicon wafers having resistivity 1 ohm-cm at 300 K. Mobility of holes is specified 400 cm^2/V-sec. What is hole concentration in units of cm^{-3} within the sample?

(a) $1x10^{16}$

(b) 1.5×10^{16}

(c) 2×10^{16}

(d) $2.5x\ 10^{16}$

Options :

1. 1

2. 2

3. 3

4. 4

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

Camera for thermal imaging with 10 micron radiation uses detector fabricated from $Hg_xCd_{1-x}Te$. What is the atom fraction x of Hg required for fabricating the photo-detector given that the band gap of $Hg_xCd_{1-x}Te$ varies with x as $E_g = 1.6 - 1.9x$ eV?

(a) 0.7

(b) 0.77

(c) 0.74

(d) 0.8

Options :

1. 1

2. 2

3. 3

4. 4

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

Intrinsic carrier density of Si at 300K is $1.5 \times 10^{10}/cm^3$. Si electron mobility $\mu_n = 1400$ cm^2/V-sec and hole mobility $\mu_p = 450$ cm^2/V-sec. What is the resistivity ρ in ohm-cm of intrinsic Si?

(a) 1.1×10^5

(b) 2.2×10^5

(c) 3.3×10^5

Options :

1. 1

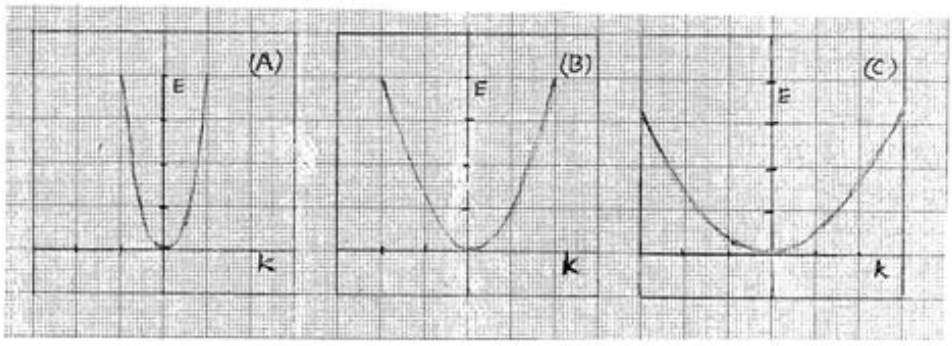
2. 2

3. 3

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

Shown below are schematics of E-k diagrams of conduction band of three different semiconductors A, B and C. Consider all the semiconductors are high purity. Which semiconductor will have the highest electron mobility?



a. A

b. B

c. C

Options :

1. 1
2. 2
3. 3

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

Light waves with wavenumber k and energy E propagate inside a medium. What is the refractive index of the medium in terms of speed of light, c?

a. $\frac{\hbar ck}{E}$

b. $\sqrt{\frac{\hbar ck}{E}}$

c. $\frac{E}{\hbar ck}$

d. $\sqrt{\frac{E}{\hbar ck}}$

Options :

1. 1
2. 2
3. 3
4. 4

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 a medium, the real and imaginary parts of the refractive index are n_o and k_o, respectively. The imaginary 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. 1
2. 2
3. 3
4. 4

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

Assuming phonon energy is negligible, for an indirect 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. 1
2. 2
3. 3
4. 4

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

A semiconductor has two optical phonon branches with energies 25 and 75 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. $(e-1)/(e^3-1)$

B. $(e^3-1)/(e-1)$

C. $(e^3+1)/(e+1)$

D. $(e+1)/(e^3+1)$

Options :

1. 1
2. 2
3. 3
4. 4

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

Energy of a free electron with mass m and wave vector $\vec{k}$ is given by:

A. $\hbar ck$ where c is speed of light
B. $\hbar^2k^2/2m$
C. 0
D. ∞

Options :

1. 1
2. 2
3. 3
4. 4

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

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 charge density is:

A. ∞
B. 0.
C. N □ a.
D. a.

Options :

1. 1
2. 2
3. 3
4. 4

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

The mobility of carriers μ_n in a semiconductor with mean scattering time τ, effective mass m and charge q is given by

A. $m/q\tau$

B. $q\tau/m$

C. qm/τ

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

The carrier diffusion coefficient D at temperature T in a semiconductor is related to carrier mobility μ_n and carrier charge q by,

A. $k_b T\mu_n/q$

B. $k_b T q/\mu_n$

C. $k_b T/6\pi\mu_n$

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

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

. The turn-on voltage of an LED will be

a) Dependent on the color of light it emits (i.e. the band gap of active layer)

b) The thickness of the electron blocking layer

c) The non-radiative lifetime of carriers

d) The IQE of the LED

Options :

1. 1
2. 2
3. 3
4. 4

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

. Regarding p-type of III-nitrides, which of the following is correct?

a) It is easier to dope AlN p-type than to dope GaN p-type

b) P-type AlGaN is used to get better p-contacts in blue and green LEDs

c) P-type GaN is always the bottom layer grown on sapphire while n-type GaN is grown at the top

d) The contact resistance to p-type GaN is usually higher than to n-type GaN

Options :

1. 1
2. 2
3. 3
4. 4

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

. Typical current levels for a blue InGaN LED device are

a) 1-100 µA

b) 1-100 mA

c) 1-100 A

d) 1-100 kA

Options :

1. 1
2. 2
3. 3
4. 4

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

Hemispherical epoxy encapsulation is typically used on LEDs because

a) It helps reduce Auger recombination

b) It helps in light extraction by reducing loss due to total internal refraction

c) It helps reduce carrier overflow in quantum wells

d) It reduces non-radiative SRH recombination

Options :

1. 1
2. 2
3. 3
4. 4

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

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

a) All phases and crystal structures of GaN are always polar

b) Piezoelectric polarization exists in tensile stressed layers only

c) Nakamura, Amano and Akasaki got the Nobel Prize in 2014 for discovering and using polarization in GaN to enable blue LED

d) Spontaneous polarization is higher in AlN than in GaN, for wurtzite phase.

Options :

1. 1
2. 2
3. 3
4. 4

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

The band gap of InGaN can be tuned with higher Indium composition to emit 650 nm (red) light as well. However, commercially available red LEDs are made of InAlGaP, and not made of InGaN because

a) Red light emitted from InGaN is harmful whereas red emission from AlInGaP is harmless
b) Higher Indium mole fraction makes InGaN lose its polarization and hence it can't emit red
c) It is extremely challenging to grow InGaN of high structural quality and with high In-composition required to emit red
d) InGaN becomes indirect band gap material at high enough Indium composition required to emit red

Options :

1. 1
2. 2
3. 3
4. 4

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

Escape cone is related to

a) Light which is not lost due to total internal refraction in an LED

b) Electrons and holes which escape from non-radiative recombination

c) Light which escapes from recombining at defects and dislocations

d) Conical shaped LEDs where light cannot escape

Options :

1. 1
2. 2
3. 3
4. 4

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

. The wall-plug efficiency of an LED

a) Depends on external quantum efficiency and the bias applied

b) Is always higher than the external quantum efficiency

c) Is always higher than internal quantum efficiency

d) Cannot be less than 10%

Options :

1. 1
2. 2
3. 3
4. 4

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

The reverse breakdown of a p-n junction

(a) is always associated with light emission in an LED

(b) is always associated with efficiency of a solar cell

(c) is important for avalanche photodiodes

(d) is important for estimating ideality factor in the diode

Options :

1. 1
2. 2
3. 3
4. 4

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

Which of the following has the largest overlap with the visible region of electromagnetic spectrum?

A. 100-200 nm
B. 200-300 nm
C. 300-400 nm
D. 400-500 nm

Options :

1. 1
2. 2
3. 3
4. 4