Semiconductor Physics - Batch CSE- E1

Cycle Test 1

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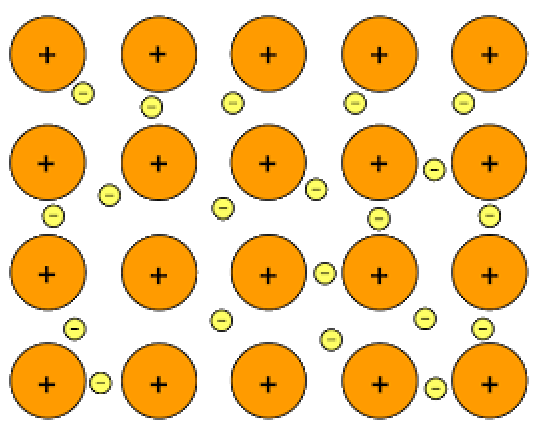
Q1 The size of an atom can be .... by measuring the distance between ....atoms in a covalent compound *

- isolated/estimated
- estimated/isolated
- calculated/neighbouring
- estimated/adjacent

Sea of electrons



Q2 You are subsumed that metallic Na, Mg & Al to have .... mobile electrons per atom, respectively *

- 1,3,&2
- 2,3,&1
- 1,2& 3
- 2,1&3

Student's Name : *

Registration No: -

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Q3 You are aware of that Paul Drude and Lorentz proposed the classical free electron theory [C-FET]. If you recall the contemporary history In 1900, they jointly suggested that ....electrons are treated as perfect gas

- mobile
- free
- conduction
- valence

Q4 C-FET arose as a consequence of ....

- ( ) Quantum mechanical Photoelectric effect
- (•) postulates of kinetic theory of gases ✓
- ( ) Semi-classical Bohr's theory
- ( ) Black-Body Radiation

Q5 A .... picked electron experiences a collision and electron travels for a time τ before the next collision. Worthwhile to note that τ is independent of an electron position and velocity. This is referred to as ....time [Hint: - Drude Theory of Electrons]

- (•) randomly/relaxation ✓
- ( ) randomly/collisions
- ( ) randomly/collided
- ( ) randomly/mean-free time

Q6 Why don't you pick up the wrong/sole (ODD) statement, which is out-of-context here

- Electron densities are thousands times greater than those of a gas at normal conditions
- Thermal conductivity of any metal is governed by electrons only
- In C-FET, the postulates of kinetic theory of gases subsume that electrons can be considered as "Neutral Gas"
- Thermal conductivity of any metal is not only governed by electrons but also phonons

Q7. In the case of Wiedemann-Franz law (1853), the value of Lorenz' no {L} centralizes of the order of ....[hint:- K/sigma = LT]

- 10+8 watt-ohm/K2
- 10-8 watt-ohm
- 10-8 watt-ohm/K2
- 10+8 watt-ohm

Q8. The Quantum free electron theory {Q-FET} was proposed by ....

- Paul-Fermi in 1928
- Sommerfeld in 1928
- Drude-Sommerfeld in 1900
- Epstein in 2020

Q9 The Fermi Level is the .... energy level which an electron can occupy at the absolute zero temperature

- ○ greatest
- ◉ highest ✓
- ○ smallest
- ○ least

Q10 The fermi velocity (Vf) of electrons was found to be approximately ~ 8.6384 E5 m/sec. Its Fermi energy (Ef) level for the metal is likely to be ....eV. Assume for free electrons' mass.

- ○ 0.21215
- ○ 2.1245
- ◉ 2.1215 ✓
- ○ 0.21235

Q11. Between the bands of allowed energies, there are empty energy regions, called .... band of energies

- ○ hidden
- ○ joebidden
- ◉ forbidden ✓
- ○ sudden

Q12 . Exactly what is a “hole” in semiconductor terminology?

- ( ) another name for a positron.
- (x) a fictitious particle that is really just an empty state in a nearly filled band ✓
- ( ) a fictitious particle that is really just an empty state in a nearly empty band
- ( ) an impurity (in small concentration) in the crystal lattice

Q13. Solving the wave equation for a given periodic potential, u(x) , can thus be really challenging. In your lecture . A periodic system of finite, rectangular quantum wells is solved. Even for this simple problem, the math is non-trivial, but the solutions display the general features of all periodic crystal potentials. What is the name of this classic, model problem for bandstructure?

- ( ) The WKB Approximation
- ( ) Fermi-Golden Rule
- (x) Kronig-Penney Model ✓
- ( ) The Pierret' Model

Q14 Bloch's theorem is about the wavefunction of an electron in a periodic potential. In the lecture, this is stated as: ψ (x + a) =ψ (x)exp{ika}; the Bloch theorem is also stated in a different, but mathematically equivalent way as:

- ψ (x + a) = u(x) exp[ikx]
- ψ (x + a) = A exp[ikx]; where A is the amplitude of the wave-function
- ψ (x) = u(x)exp[ik(x+a)]
- ψ (x) = u(x) exp(ikx), ,where u(x) is the periodic, crystal potential: u(x + a) = u(x)

Q15 What is a Brillouin zone?

- A region of energy-space that encompasses all of the unique values of energy
- Another name for the unit cell of the crystal
- A region of k-space that contains all of the unique solutions of the wave equation
- A region of k-space where the group velocity is positive

Q16 Effective mass is a widely-used concept in semiconductors. Find the exclusive option/expression given for "Effective Mass"!!@@

- m* = hυF
- m*/m0 > 1
- m* = 0
- m* = ∞

Q17 For a bandstructure with E [kx ,ky] = h^2 kx^2/2m* + h^2 ky^2/2m* what is the shape of the constant energy “surface.” Here m* is the effective mass of electron(s). Read as kx and ky as wave-propagation vectors along "x" & "y" axes.

- ( ) a line
- (•) a circle ✓
- ( ) a ellipse
- ( ) a sphere

Q18 The minimum .... required to the break the covalent bond in germanium crystal is 0.72 eV and for silicon its value is 1.1 eV.

- (•) potential ✓
- ( ) energy
- ( ) ionic
- ( ) shift

Q19 The boundary condition of first Brillouin zone may be represented as "= k values" ;

- (•) +pi/a to - pi/a ✓
- ( ) pi/1 to -pi/1
- ( ) pi/2a to -pi/2a
- ( ) 0 to infinity

Q20 . Referring to Fermi-Dirac Statistics, the occupancy function FE) of electrons (Fermions) is digital. The so-called/arid word "DIGITAL" refers

- F[E] has the maximum value of infinity and minimum value of zero
- F[E] has the minimum value of infinity and maximum value of zero
- F[E] has the maximum value of 1.0 and minimum value of -1.0
- F[E] has the maximum value of 1.0 and minimum value of 0.0 ✓

Q21 In P Type semiconductors, the majority charged carriers are_____

- electrons
- fermions
- holes ✓
- bosons

Q22 In direct BG SCs (bandgap semiconductors), the probability of a .... recombination is ....

- small/radiative
- radiative/large
- radiative/high ✓
- least/readiative

Q23. What is phonon density and why is it proportional to temperature? Phonons (lattice vibrations) have quantized frequencies and modes, with associated energy levels (“states”). Since total vibration energy ....proportionately with temperature, the probability of finding a phonon in a higher-energy state increases; hence the number of phonons increases with temperature – and the average time between lattice-scattering events decreases.

- cant' say
- decreases
- remains
- increases

Q24 Even in steady-state equilibrium conditions, the total currents are due to

- the summation of electrons' drift and holes' drift currents
- the plus of electrons' & holes' drift and diffusion currents
- the plus of electrons' & holes' diffusion currents
- the summation of electrons' & holes' drift currents

Q25. Why dont you give the suitable title !!@@

- ○ Differentiate the Fermi Function, F(E), for energy kT just above the Fermi energy EF
- ○ Measure the Fermi Function, F(E), for energy kT just above the Fermi energy EF
- ○ Identify the Fermi Function, F(E), for energy kT just above the Fermi energy EF
- ◉ Evaluate the Fermi Function, F(E), for energy kT just above the Fermi energy EF ✓

Given: Fermi function $f(E) = ?$

Boltzmann's con stant $k = 1.38 \times 10^{-23} J/K$

Kelvin's temperature T=300K

Formula:

$$f(E) = \frac{1}{1+e^{(E-E_F)/kT}}$$

Solution:- We have the formula,

$$f(E) = \frac{1}{1+e^{(E-E_F)/kT}}$$

Here, $(E - E_F) = kT$ then

$$f(E) = \frac{1}{1+e^1} = \frac{1}{1+2.78} = \frac{1}{3.78} = 0.269$$

Q26. You have just stepped up a new dimensions in this "Flexible Curricula" where do you have multifaceted. How do you feel after completing this allocated task to you. Revive this picture and affiliate with this emoji {emoticon]

- (selected) Relaxed- mindset plays a vital role ✓
- Deprived- mindset plays a typical role
- Desperately needs long rest
- Helps us to have "driving forces"