Engineering Physics (2025)
Course code 25PY101
T4 MCQ bank

Course Instructor:
Dr. Sreekar Guddeti
Assistant Professor in Physics
Department of Science and Humanities
Vignan's Foundation for Science, Technology and Research

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Question 1

Conductivity of metal vs semiconductor

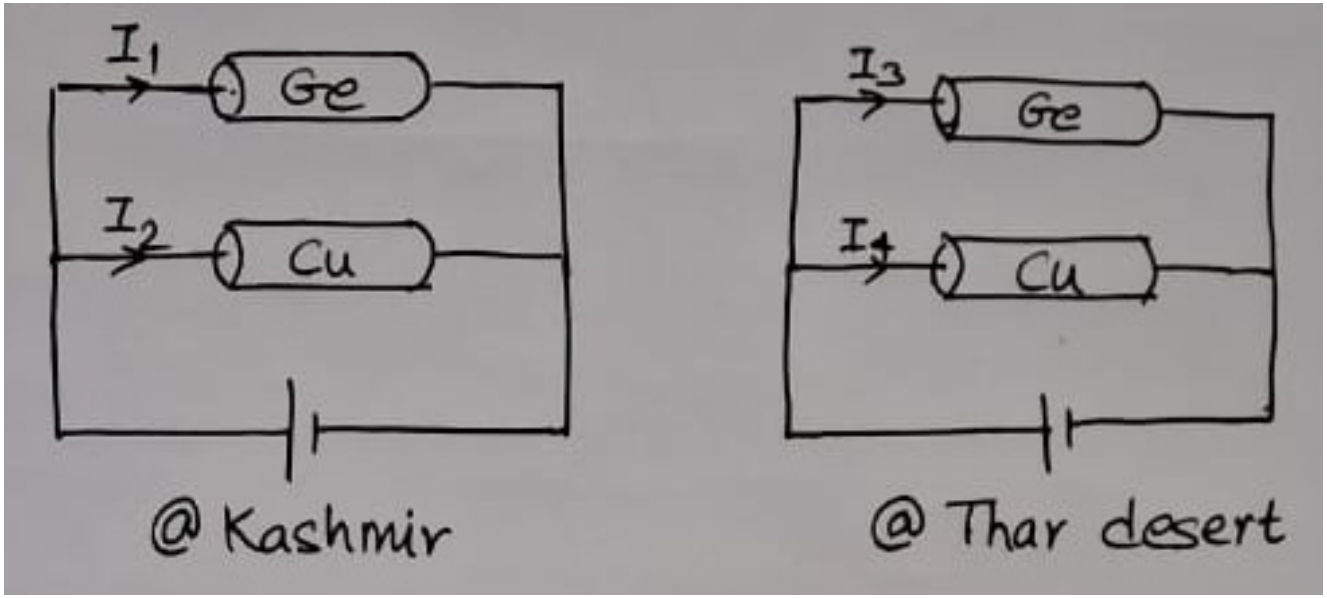


Figure: Choose **True** statement.

- $I_1 > I_2$
- $I_2 > I_4$
- $I_2 < I_4$
- $I_3 < I_1$

Question 2

Conductivity of metal vs semiconductor

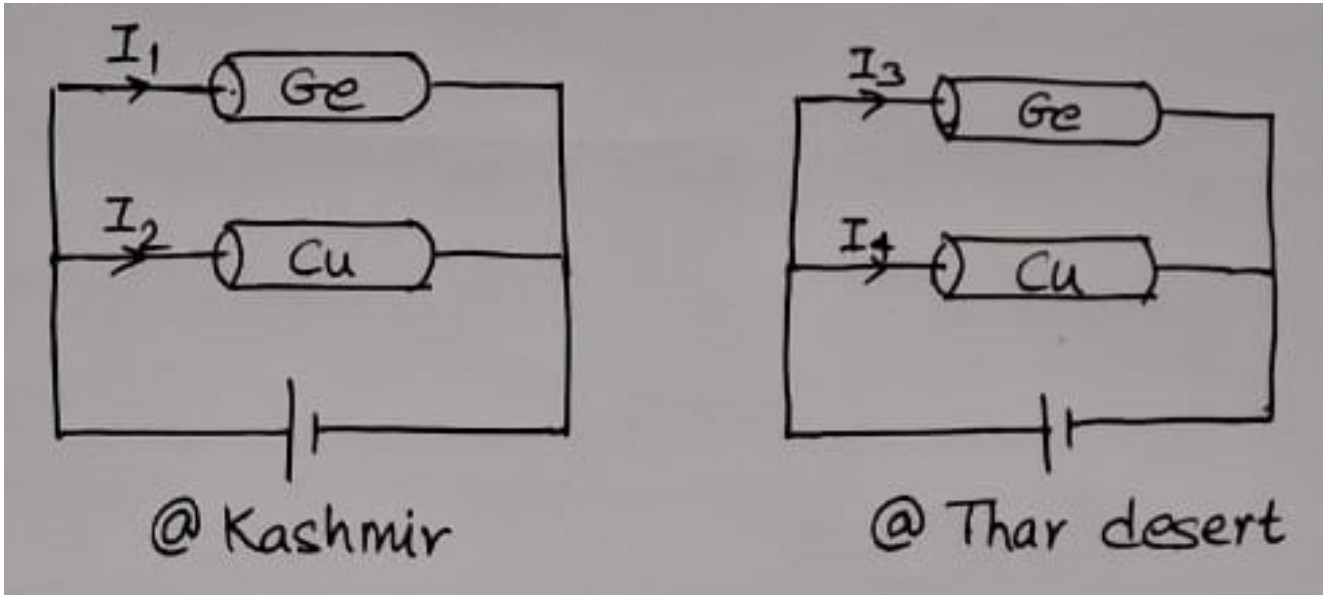


Figure: Choose **False** statement.

- $I_2 > I_1$
- $I_1 < I_3$
- $I_2 > I_4$
- $I_4 < I_3$

Question 3

Hall effect

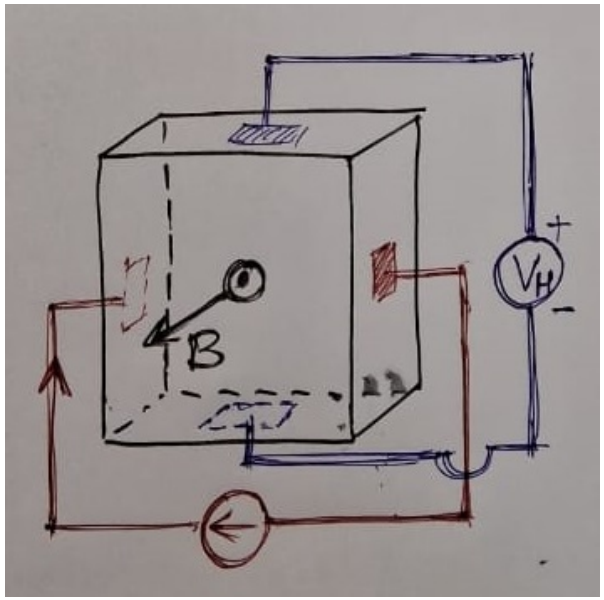


Figure: Choose **True** statement.

- p-type and $V_H < 0$ and $B > 0$
- p-type and $V_H > 0$ and $B > 0$
- n-type and $V_H < 0$ and $B > 0$
- n-type and $V_H > 0$ and $B < 0$

Question 4

Hall effect

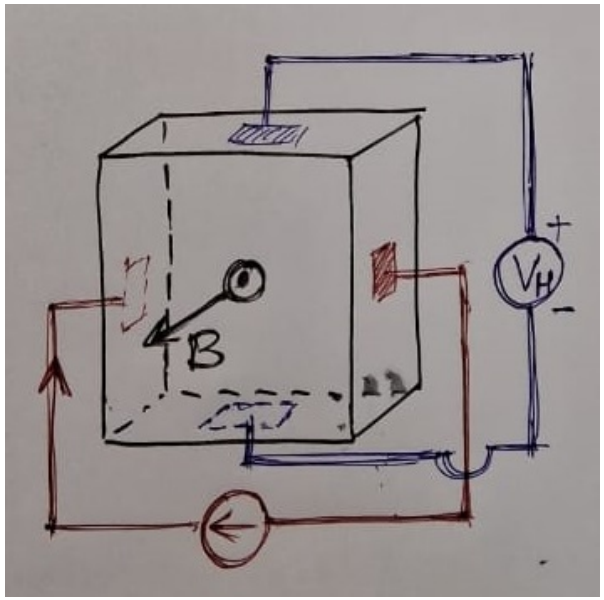


Figure: Choose **False** statement.

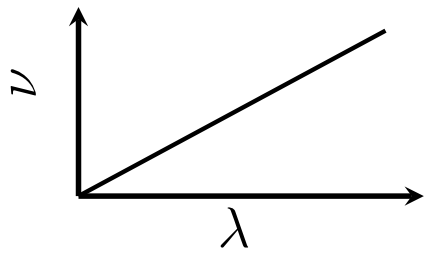
- p-type and $V_H > 0$ and $B > 0$
- p-type and $V_H < 0$ and $B > 0$
- n-type and $V_H > 0$ and $B > 0$
- n-type and $V_H < 0$ and $B < 0$

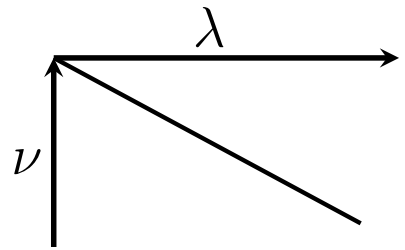
Question 5

Planck's black body radiation law

Dependence of photon frequency ν on the wavelength λ of photon is given by

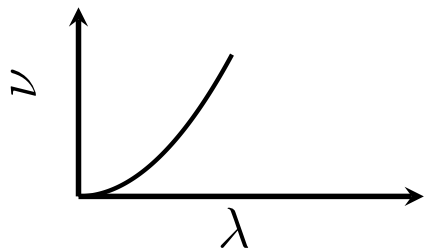
(A)

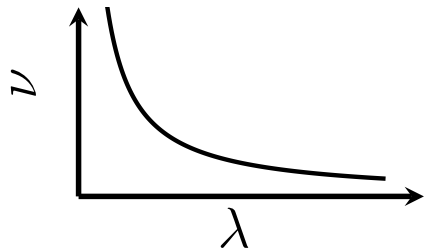




(B)

(C)





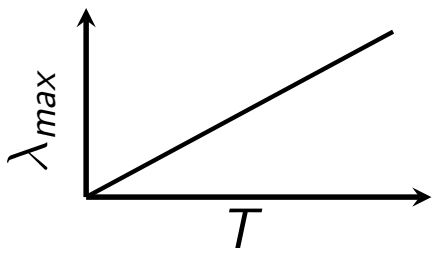
(D)

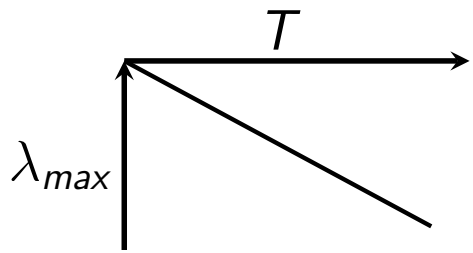
Question 6

Planck's black body radiation law

Dependence of wavelength with maximum intensity λ_{max} on the temperature T of black body is given by

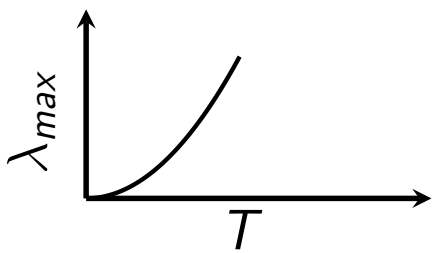
(A)

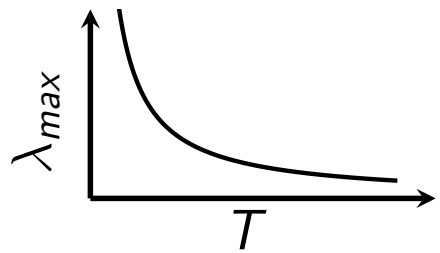




(B)

(C)





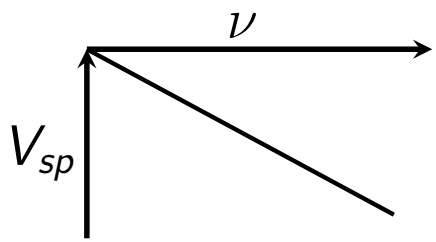
(D)

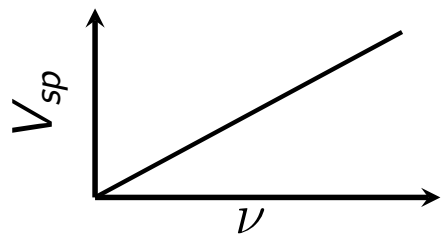
Question 7

Photo-electric effect

Dependence of stopping potential V_{sp} on the photon frequency ν is given by

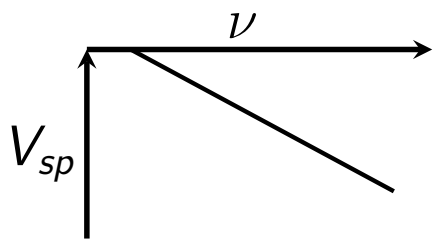
(A)

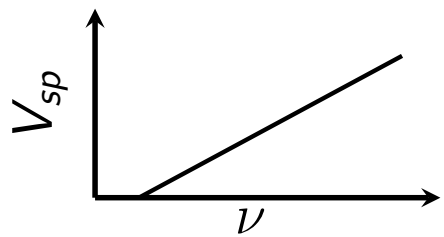




(B)

(C)





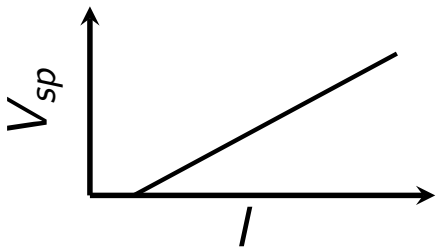
(D)

Question 8

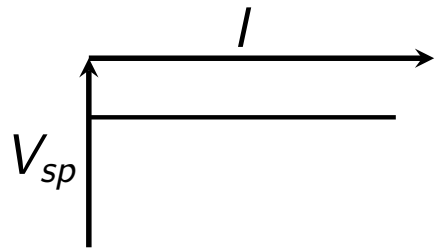
Photo-electric effect

Dependence of stopping potential V_{sp} on the intensity I of light of fixed frequency is given by

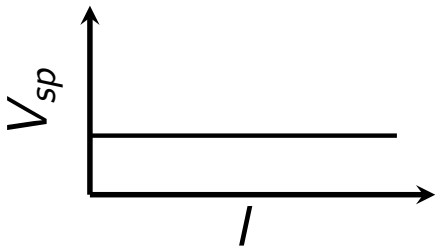
(A)



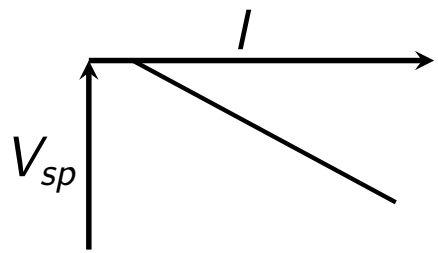
(B)



(C)



(D)



Question 9

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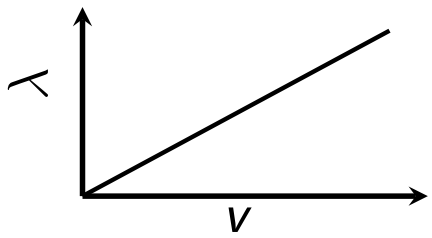
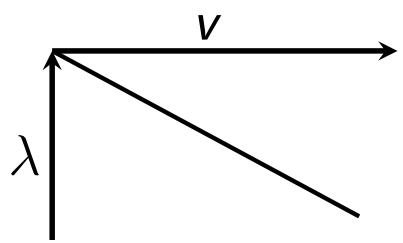
de Broglie's matter wave

Dependence of de Broglie wavelength λ on the velocity v of electron is given by

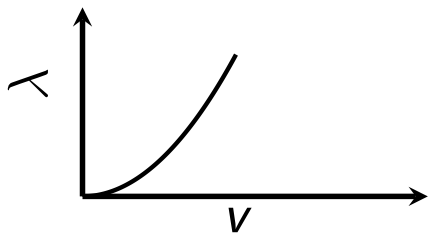
(A)



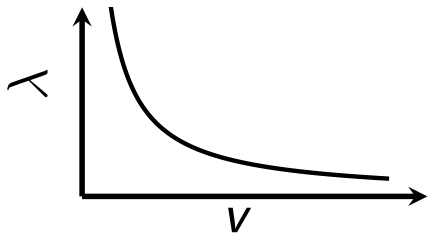
(B)



(C)



(D)



Question 10

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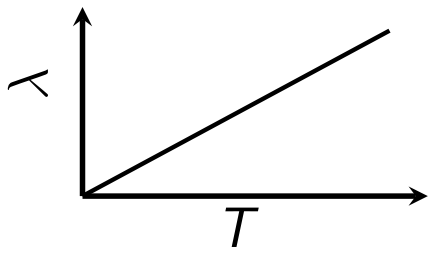
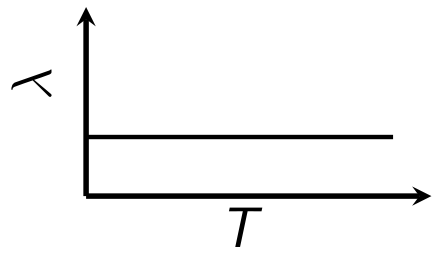
de Broglie's matter wave

Dependence of de Broglie wavelength λ on the temperature T of electron is given by

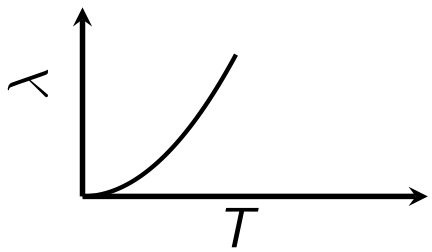
(A)

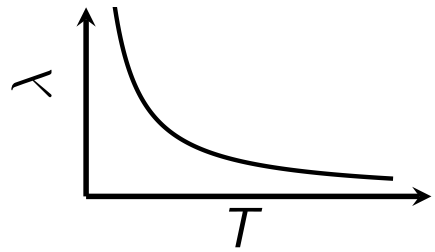




(B)

(C)





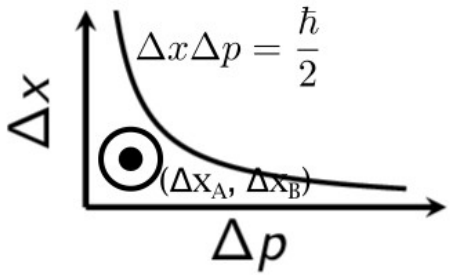
(D)

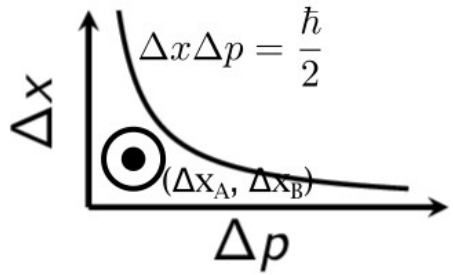
Question 11

Heisenberg's uncertainty principle

In an experiment A, the uncertainty in position Δx_A and uncertainty in momentum Δp_A are measured. which of the following graphs is impossible?

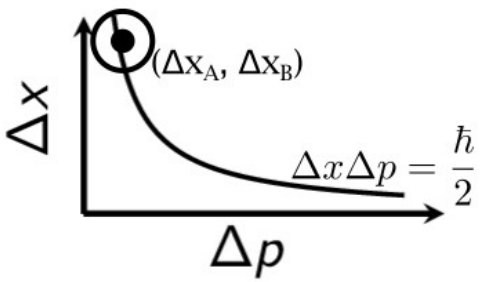
(A)

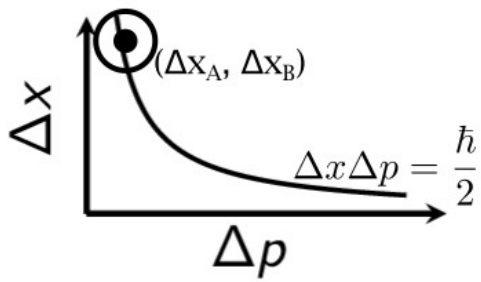




(B)

(C)





(D)

Question 12

Heisenberg's uncertainty principle

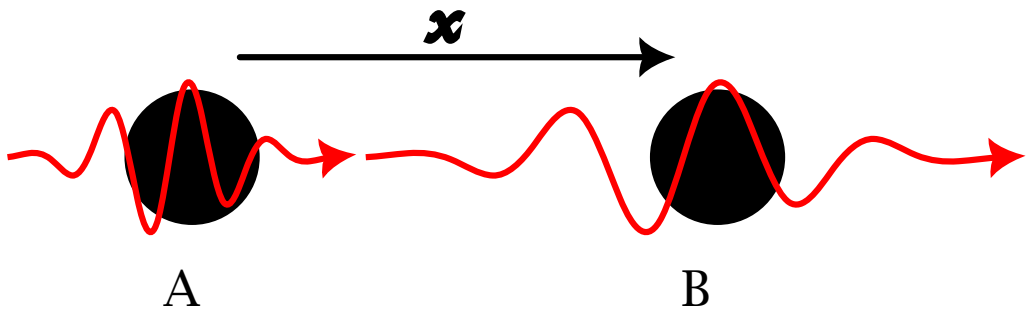


Figure: Choose **True** statement.

- uncertainty in position of A is greater than uncertainty in position of B
- uncertainty in momentum of A is greater than uncertainty in momentum of B
- uncertainty in position of A is equal to uncertainty in position of B
- uncertainty in momentum of A is equal to uncertainty in momentum of B

Question 13

Schrödinger Wave Equation

Two particles A and B of same mass have spatial part of their wavefunctions as follows

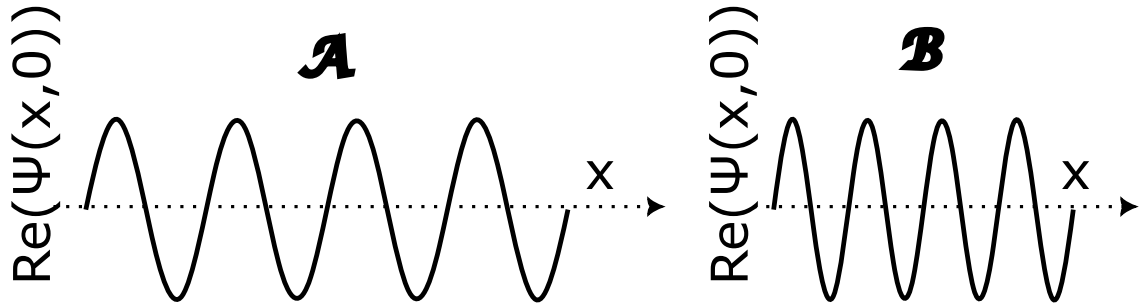


Figure: Choose **False** statement.

- Wavelength of A is greater than wavelength of B
- Kinetic energy of A is greater than kinetic energy of B
- Momentum of A is lesser than momentum of B
- Wavevector of A is lesser than wavevector of B

Question 14

Schrödinger Wave Equation

Two particles A and B of same mass have temporal part of their wavefunctions as follows

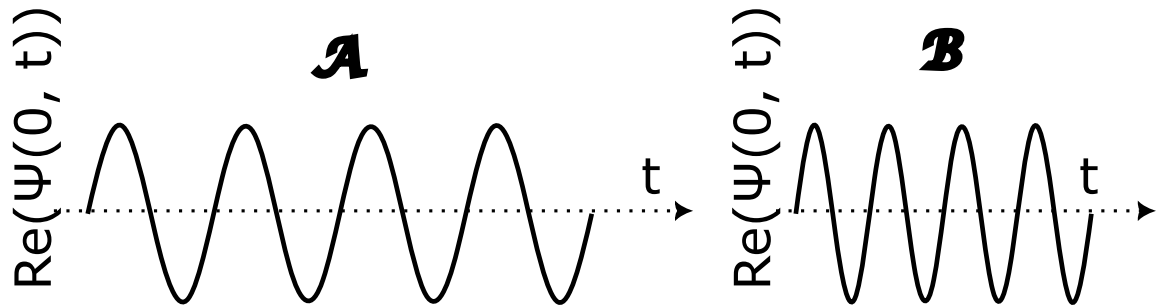


Figure: Choose **True** statement.

- Frequency of A is greater than frequency of B
- Time period of A is lesser than time period of B
- Kinetic energy of A is lesser than kinetic energy of B
- Angular frequency of A is greater than angular frequency of B

Question 15

Particle in a 1D box

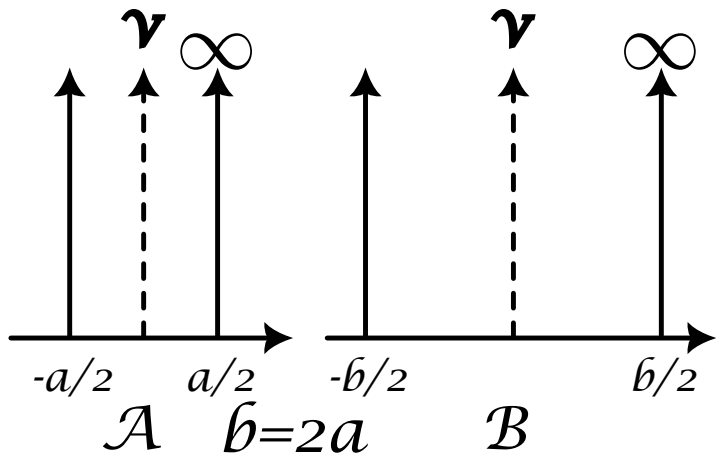


Figure: Choose **False** statement.

- $k_1^A > k_1^B$
- $k_2^A < k_2^B$
- $k_1^A = k_2^B$
- $k_2^A = 4k_1^B$

Question 16

Particle in a 1D box

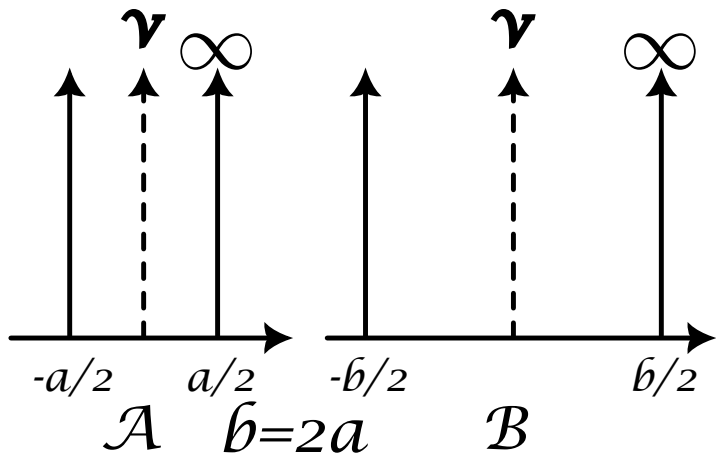


Figure: Choose **True** statement.

- $E_1^A = 2E_1^B$
- $E_1^B = 2E_1^A$
- $E_1^A = 4E_1^B$
- $E_1^B = 4E_1^A$

Question 17

Particle in a 1D box

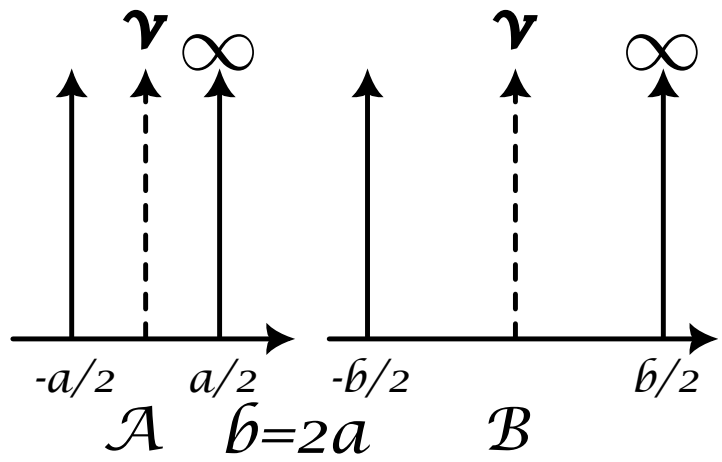


Figure: Choose **False** statement.

- $E_n \propto n^2$
- $E_n \propto \frac{1}{n^2}$
- $k_n \propto n$
- $E_n = \frac{\hbar^2 k_n^2}{2m}$

Question 18

Quantum dot

Cubic quantum dots A and B are fabricated with sidelength $a_A > a_B$.

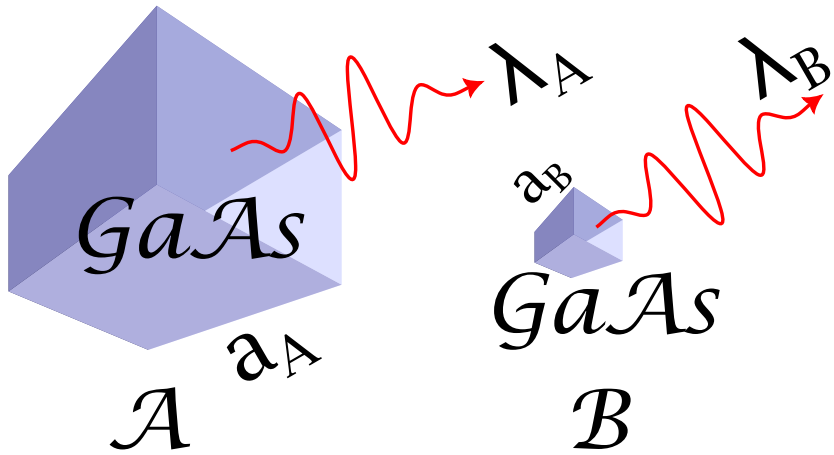


Figure: Choose **True** statement.

- $E_g^A > E_g^B$
- $E_g^A < E_g^B$
- $\lambda_g^A < \lambda_g^B$
- $\nu_g^A > \nu_g^B$

Question 19

Finite potential well

Two particles A and B of same mass are placed in infinite potential well and finite potential well of same width respectively.

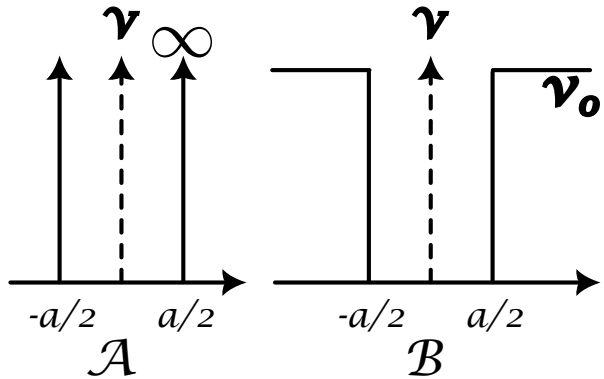


Figure: Choose **False** statement.

- $E_1^A < E_1^B$
- $E_1^A > E_1^B$
- $\psi_1^A(x)$ is even function
- $\psi_1^B(x)$ is even function

Question 20

Finite potential well

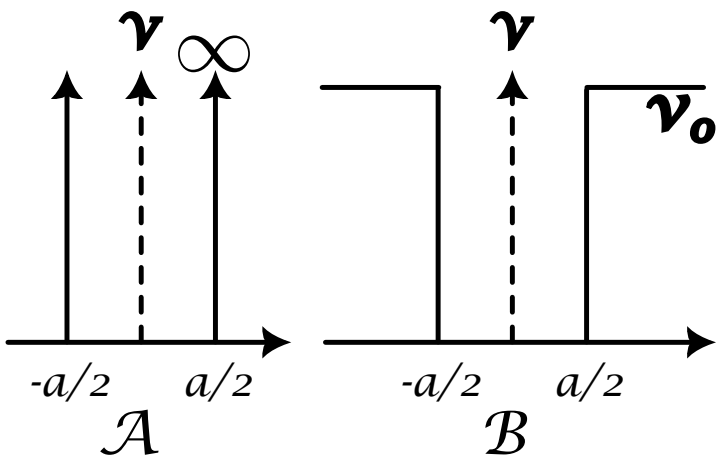


Figure: Choose **True** statement.

Ans: B

$$k_1^A = \begin{cases} \text{imaginary} & x \in (-\infty, -a/2] \\ \text{real} & x \in [a/2, -a/2] \\ \text{imaginary} & x \in [a/2, \infty) \end{cases}$$

$$k_1^B = \begin{cases} \text{imaginary} & x \in (-\infty, -a/2] \\ \text{real} & x \in [a/2, -a/2] \\ \text{imaginary} & x \in [a/2, \infty) \end{cases}$$

$$k_1^A = \begin{cases} \text{real} & x \in (-\infty, -a/2] \\ \text{imaginary} & x \in [a/2, -a/2] \\ \text{real} & x \in [a/2, \infty) \end{cases}$$

$$k_1^B = \begin{cases} \text{real} & x \in (-\infty, -a/2] \\ \text{imaginary} & x \in [-a/2, -a/2] \\ \text{real} & x \in [a/2, \infty) \end{cases}$$

Question 21

Finite potential well

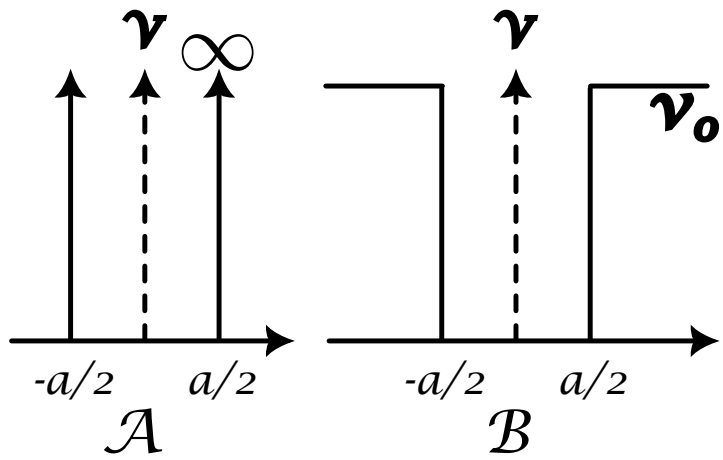


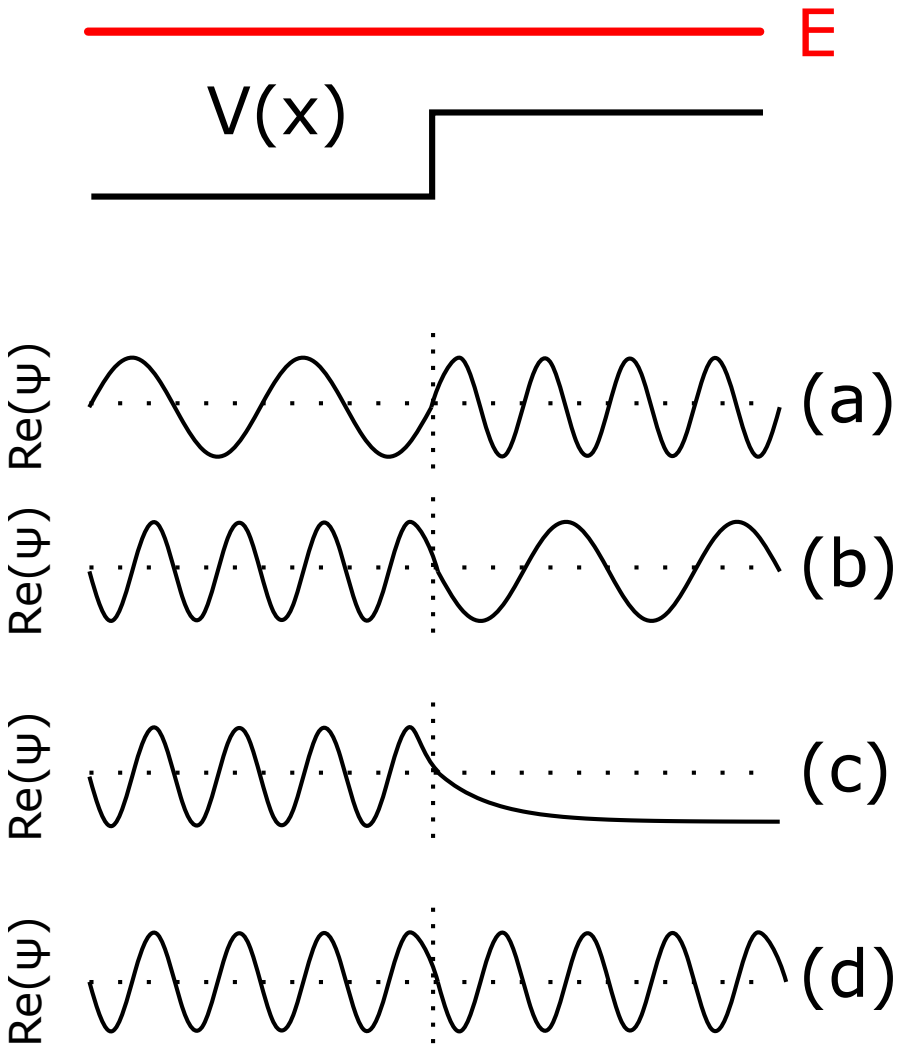
Figure: Choose **False** statement.

- $T^A > 0$ always
- $T^B > 0$ always
- k^A is always real
- k^A is never imaginary

Question 22 Ans: B

Quantum tunneling

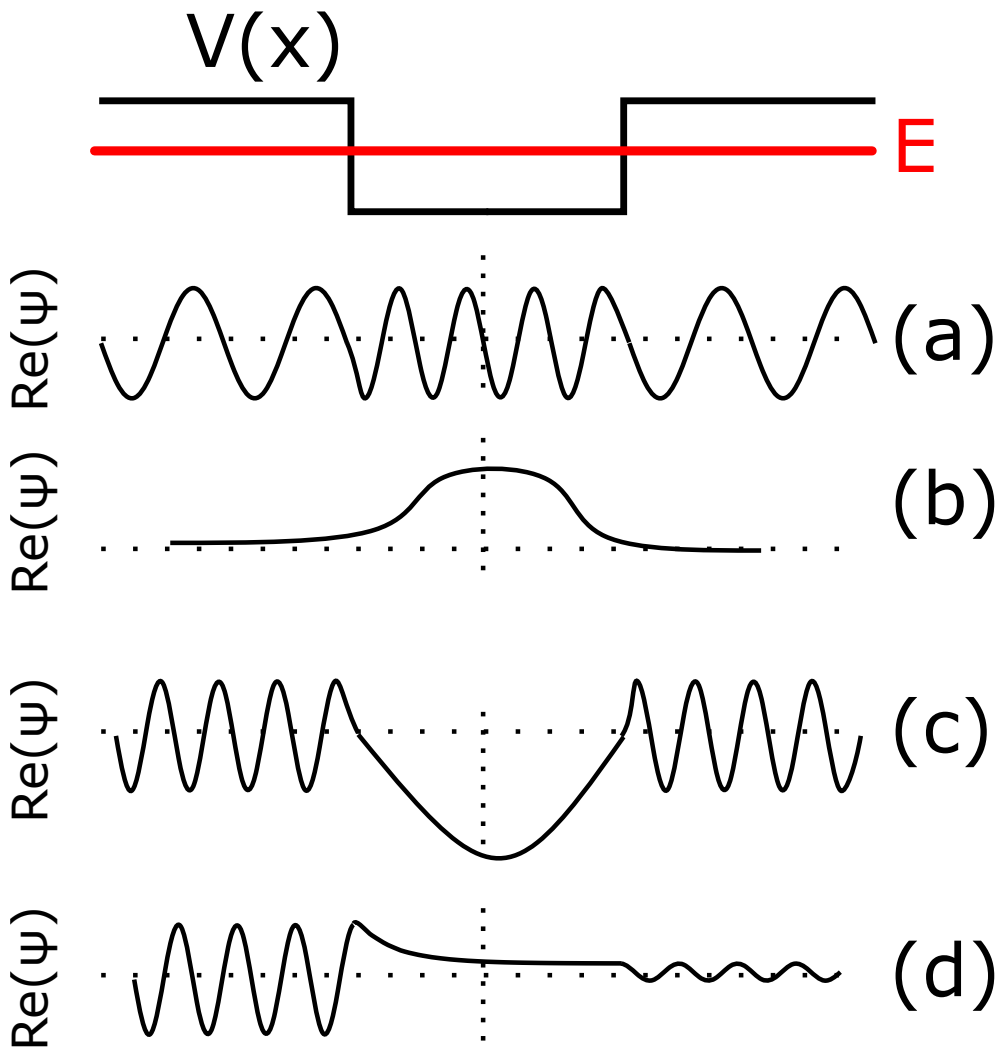
Choose the wavefunction.



Question 23 Ans: B

Quantum tunneling

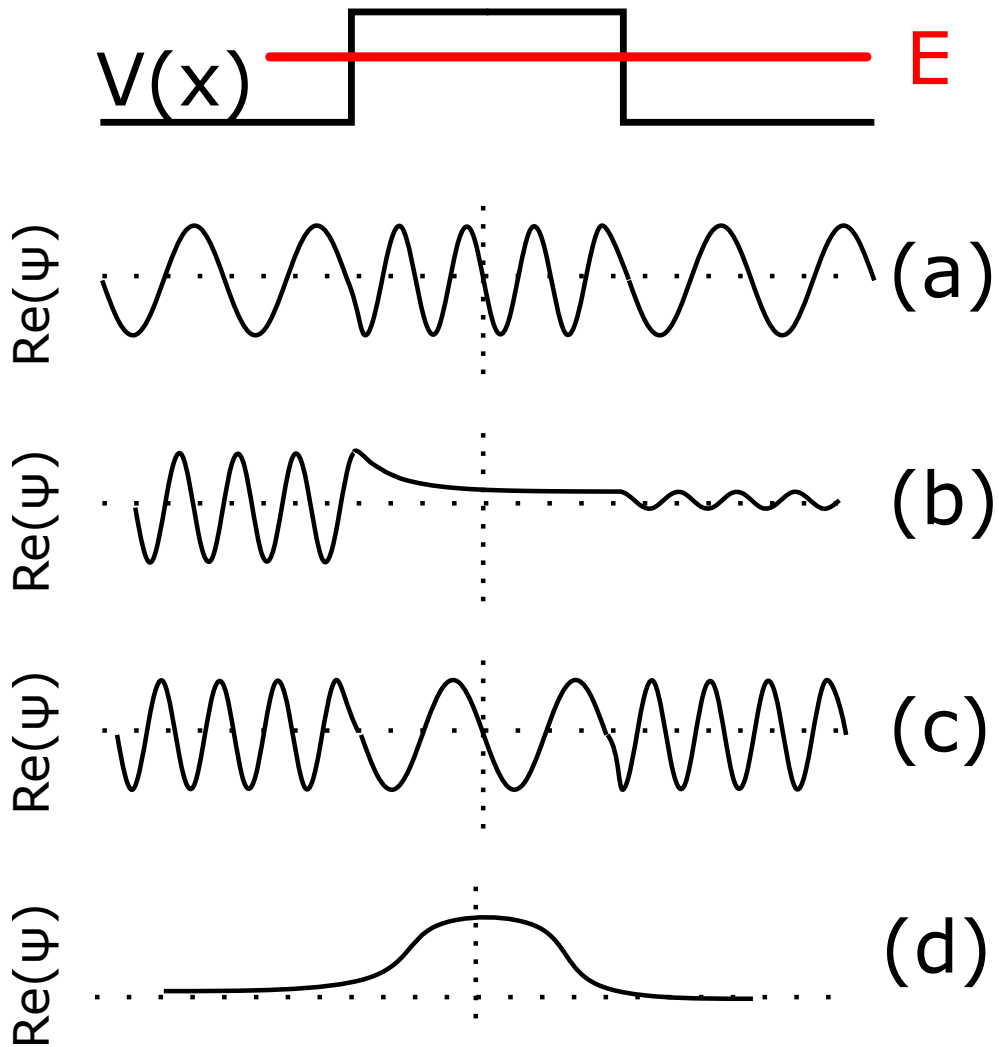
Choose the wavefunction.



Question 24 Ans: B

Quantum tunneling

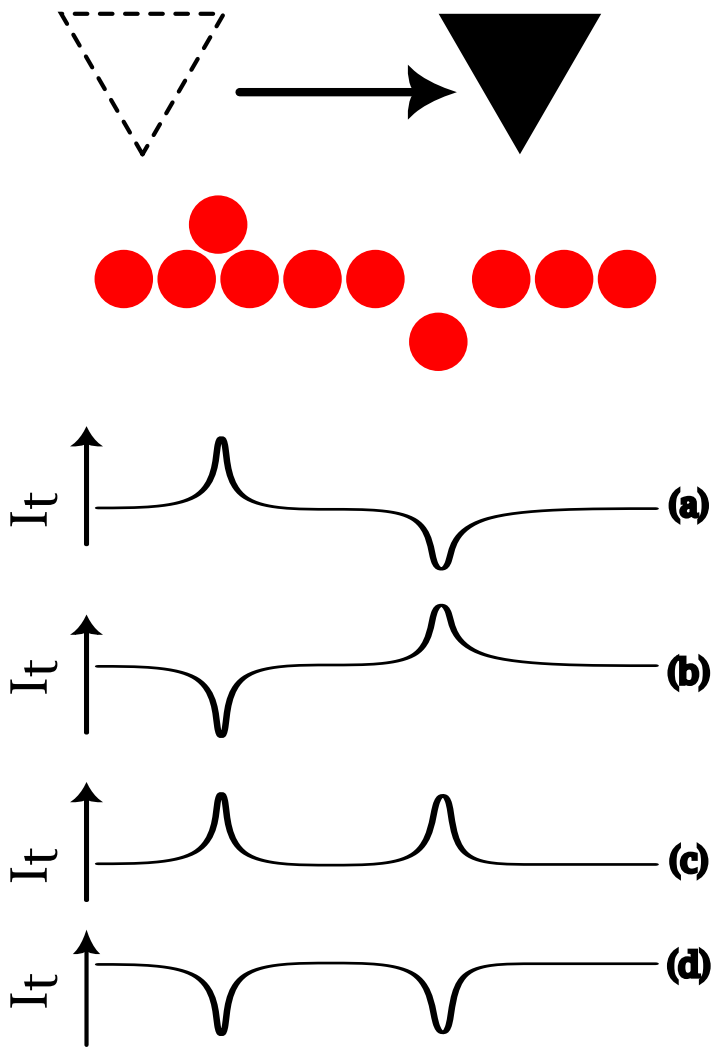
Choose the wavefunction.



Question 25 Ans: A

Scanning Tunneling Microscope

Choose the tunneling current profile.



Question 26

QFET

Choose **False** statement.

- QFET is based on wave nature of electron.
- QFET is based on particle nature of electron.
- QFET is based on Pauli's exclusion principle.
- QFET is based on Fermi-Dirac statistics.

Question 27

QFET

Choose **True** statement. Pauli's exclusion principle is not satisfied by

- electron
- proton
- photon
- neutron

Question 28

Fermi-Dirac distribution

Choose **False** statement. Fermi-Dirac distribution

- is based on wave nature of electron
- is based on Pauli's exclusion principle
- is obeyed by particles with half-integral spin
- approximates to Maxwell-Boltzmann distribution at low temperature.

Question 29

Fermi-Dirac distribution

Choose **True** statement.

- $P_{FD}(E) \sim 0$ for $E \ll E_F$ at $T \neq 0\,\mathrm{K}$
- $P_{FD}(E) = 0$ for $E < E_F$ at $T = 0\,\mathrm{K}$
- $P_{FD}(E) = 1$ for $E > E_F$ at $T = 0\,\mathrm{K}$
- $P_{FD}(E) \sim 1$ for $E \ll E_F$ at $T \neq 0\,\mathrm{K}$

Question 30

Electronic specific heat of metals

Choose **False** statement. Specific heat of metals

- is due to thermalization of electrons only near the Fermi level
- is explained by QFET
- is dominated more by electronic contribution than by phononic contribution
- is dominated more by phononic contribution than by electronic contribution

Question 31

Electronic specific heat of metals

Choose **True** statement. Electronic specific heat of metals is

- $\propto T$
- $\propto 1/T$
- independent of T
- $\propto T^3$

Question 32

Density of states function

Choose **False** statement. DOS function is based on

- wave nature of electron
- Fermi-Dirac distribution
- $\propto \sqrt{E}$ for 3D metal
- constant for 2D metal

Question 33

Density of states function

Choose **True** statement. DOS function for a metal is $Z(E) = k\sqrt{E}$. If the carrier concentration is n, then the Fermi level at 0 K is given by

- $\left(\frac{3n}{2k}\right)^{2/3}$
- $\left(\frac{3n}{2k}\right)^{3/2}$
- $\left(\frac{2n}{3k}\right)^{3/2}$
- $\left(\frac{2n}{3k}\right)^{2/3}$

Question 34

$E - k$ diagram

Choose **False** statement.

- $E - k$ diagram of free electron has parabolic form
- $E - k$ diagram of free electron has linear form
- $E - k$ diagram of electron in periodic potential can have forbidden energy levels
- $E - k$ diagram of free electron has no forbidden energy levels

Question 35

$E - k$ diagram

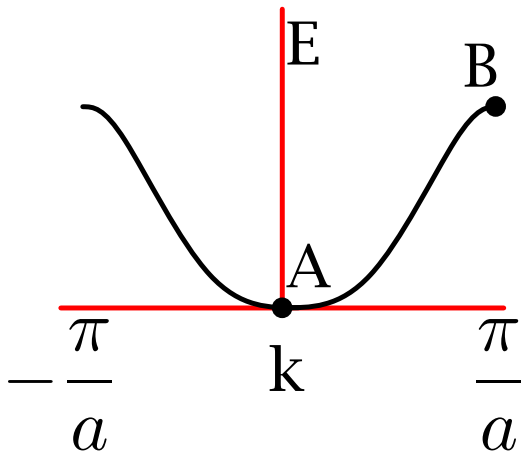


Figure: Choose **True** statement.

- $m_A^* > 0$ and $m_B^* > 0$
- $m_A^* > 0$ and $m_B^* < 0$
- $m_A^* < 0$ and $m_B^* > 0$
- $m_A^* < 0$ and $m_B^* < 0$

Question 36

Fermi level in s.c.

Choose **False** statement. For an intrinsic semiconductor

- if electron effective mass equals hole effective mass, then Fermi level lies at midgap.
- if electron effective mass is less than hole effective mass, then Fermi level lies below midgap.
- At 0 K, Fermi level is at midgap.
- if electron effective mass is less than hole effective mass, then Fermi level lies above midgap.

Question 37

Fermi level in s.c.

Choose **True** statement. For an n-type semiconductor,

- Dopants are acceptors.
- Fermi level is closer to valence band.
- At 0 K, Fermi level is below donor level.
- At 300 K, Fermi level is below donor level.

Question 38

pn junction

Choose **False** statement. In a pn junction diode under forward bias,

- the depletion region width increases.
- the depletion region width decreases.
- the potential energy barrier decreases.
- net electric field in space charge region decreases.

Question 39

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pn junction

Choose **True** statement. In a pn junction diode,

- forward current is less than reverse current.
- depletion region width under forward bias is more than depletion region width under reverse bias.
- junction capacitance under forward bias is more than junction capacitance under reverse bias.
- potential energy barrier under forward bias is more than potential energy barrier under reverse bias.

Question 40

Solar cell

Choose **False** statement. Solar cell

- is based on photo-voltaic effect.
- operates under forward bias.
- has I-V characteristics in the fourth quadrant.
- operates under zero bias.

Question 41

Solar cell

Choose **True** statement. A material is useful for solar cell application

- if it has an indirect band gap.
- if it has high optical absorption coefficient for visible light range.
- if it has small depletion region width.
- if it has low doping of the p and n regions.

Question 42

Direct vs indirect band gap semiconductor

Choose **False** statement.

- Direct band gap semiconductor has $k@E_c = k@E_v$.
- Indirect band gap semiconductor has $k@E_c \neq k@E_v$.
- Direct band gap semiconductor is useful for opto-electronic applications.
- Indirect band gap semiconductor is useful for opto-electronic applications.

Question 43

Direct vs indirect band gap semiconductor

Choose **True** statement.

- In an indirect band gap semiconductor, rate of radiative recombination is greater than rate of non-radiative recombination.
- In a direct band gap semiconductor, rate of radiative recombination is lesser than rate of non-radiative recombination.
- In a direct band gap semiconductor, radiative recombination lifetime is larger than non-radiative recombination lifetime.
- In a direct band gap semiconductor, radiative recombination lifetime is smaller than non-radiative recombination lifetime.

Question 44

LED

Choose **True** statement. LED is based on

- photo-voltaic effect.
- electro-luminescence.
- photo-luminescence.
- photo-conductive effect.

Question 45

LED

Choose **False** statement. LED

- operates under forward bias.
- is made up of direct band-gap semiconductor.
- operates under reverse bias.
- has $I - V$ characteristics in the first quadrant.

Question 46

Photo-diode

Choose **True** statement. Photo-diode is based on

- photo-conductive effect.
- photo-voltaic effect.
- electro-luminescence.
- photo-luminescence.

Question 47

Photo-diode

Choose **False** statement. Photo-diode

- operates under reverse bias.
- has $I - V$ characteristics in the fourth quadrant.
- has low junction capacitance.
- has large depletion region width.

Question 48

Tunneling diode

Choose **True** statement. Tunneling diode

- consists of degenerately doped p and n regions.
- consists of non-degenerately doped p and n regions
- depletion region width is of the order of 100 nm.
- Fermi level is inside the band gap.

Question 49

Tunneling diode

Choose **False** statement. As the forward bias of tunneling diode is increased,

- there is a region of negative differential resistance.
- tunneling current first increases, then decreases and finally increases.
- tunneling current first decreases, then increases and finally decreases.
- there are two regions of positive differential resistance.

Question 50

Light-matter interaction

Choose **True** statement. Which of these processes is not allowed?

- Spontaneous absorption
- Spontaneous emission
- Stimulated absorption
- Stimulated emission

Question 51

Light-matter interaction

Choose **False** statement. At thermal equilibrium,

- spontaneous emission dominates stimulated emission.
- stimulated emission dominates spontaneous emission.
- rate of stimulated emission equals rate of stimulated absorption.
- population of levels is governed by Maxwell-Boltzmann distribution.

Question 52

Lasing action – conditions

Choose **False** statement. The conditions for lasing action are

- High photon density.
- Large lifetime of excited state.
- Population of excited state must be higher than population of ground state.
- High rate of spontaneous emission.

Question 53

Lasing action – requirements

Choose **False** statement. The requirements of lasing action are

- metastable state.
- population inversion.
- confinement of radiation.
- thermal equilibrium.

Question 54

Laser – components

Choose **False** statement. The components of laser are

- active medium.
- pump.
- optical resonator.
- none of the other options.

Question 55

Laser – components

Choose **True** statement. In a laser, the following hosts the metastable state –

- active medium.
- pump.
- optical resonator.
- none of the other options.

Question 56

Laser – characteristics

Choose **False** statement. The characteristics of laser are –

- high monochromaticity.
- high degree of coherence.
- unidirectionality.
- large pulse width.

Question 57

Laser – characteristics

Choose **True** statement. Unidirectionality of laser is achieved due to –

- Fabry-Perot interferometer.
- active medium.
- pump.
- metastable state.

Question 58

Diode laser

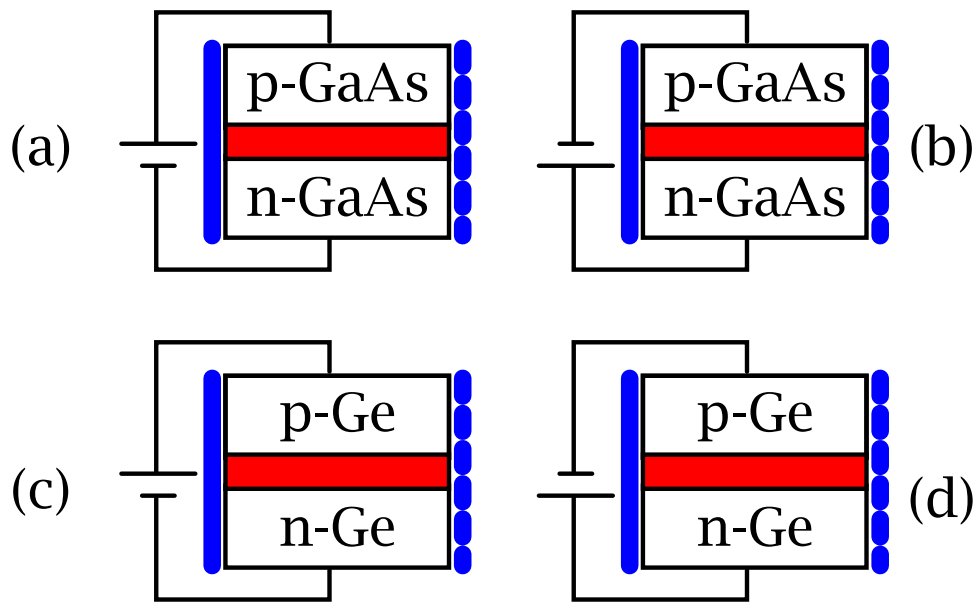
Choose **False** statement. In a diode laser,

- forward-biasing is the pump.
- depletion region is the active medium.
- Fabry-Perot interferometer is the optical resonator.
- lasing action is initiated at lower threshold current in homo-junction diode laser compared to higher threshold current in hetero-junction diode laser.

Question 59 Ans: A

Diode laser

Choose **True** statement. The construction of diode laser is given by



Question 60

Optical fibre communication

Choose **True** statement. The propagation delay is defined as the time taken for the signal to travel from sender to receiver. The propagation delay for the signal to reach India from North America via optical fibre is of the order of

- 1 ms
- 100 ms
- 1 s
- 1 µs

End of MCQ bank