Question

The group velocity of a wave with a phase velocity of 60×10^9 is (in 10^6 order)

A. 1.5

B. 2

C. 2.5

D. 3

- [x] A.
- [ ] B.
- [ ] C.
- [ ] D.

Clear selection

Question

The de-Broglie wavelength 'λ' of a particle:

(A)is proportional to mass

(B)is proportional to impulse

(C)is inversely proportional to impulse

(D)does not depend on impulse

- ○ A.
- ○ B.
- ◉ C.
- ○ D.

Clear selection

Question

The solution to the Schrodinger equation for a particle bound in a one-dimensional, infinitely deep potential well, indexed by a quantum number *n*, indicates that in the middle of the well, the probability density vanishes for.

A. all states except the ground state

B. states of even n(n = 2, 4 ...)

C. [illegible]

Question

When monochromatic light of wavelength 'λ' is incident on a metallic surface, the stopping potential for photoelectric current is '3V'. When same surface is illuminated with light of wavelength '2λ', the stopping potential is 'V'. The threshold wavelength for this surface when photoelectric effect takes place is:

(A) λ (B) 2λ (C) 3λ (D) 4λ

- A.
- B.
- C.
- D.

Clear selection

Probability of finding a particle between 0 to 0.5 L in a one-dimensional box of length L in the second excited state is:

1. $\frac{1}{2} + \frac{1}{3\pi}$

2. ½

3. 1/3π

4. $\frac{1}{4} + \frac{1}{6\pi}$

Answer (Detailed Solution Below)

Option 2 : ½

A non dispersive media has:

1. Group velocity > phase velocity

2. Group velocity < phase velocity

3. Group velocity = phase velocity

4. None of above

- ( ) 1.
- ( ) 2.
- (x) 3.
- ( ) 4.

The position of both, an electron and a helium atom is known within 1.0 mm. Further more the momentum of the electron is known within 5.0×10^{-26} kg ms^{-1}. The minimum uncertainty in the measurement of the momentum of the helium atom is

A. 50.0 kg ms^{-1}

B. 80.0 kg ms^{-1}

C. 80.0×10^{-26} kg ms^{-1}

D. 5.0×10^{-26} kg ms^{-1}

- ○ A
- ○ B
- ○ C
- ◉ D

Question

A photon and an electron have the same wavelength then:

A. photon has greater momentum

B. electron has greater momentum

C. both have the same momentum

D. none of the above

- A.
- B.
- C.
- D.

Clear selection

Question

In an atom, an electron is moving with a speed of 600 ms^{-1} with an accuracy of 0.005%. Certainty with which the position of the electron can be located is

$[h = 6.6 \times 10^{-34}$ Js, $m_e = 9.1 \times 10^{-31}$ kg$]$

A. 1.52×10^{-4} m

B. 5.10×10^{-3} m

C. 1.92×10^{-3} m

D. 3.84×10^{-3} m

- ○ A
- ○ B
- ◉ C
- ○ D

Question

The ground state energy of an electron confined to a box 1Å wide is.

A. 6.016×10^{-20}J
B. 2.016×10^{-18}J
C. 5.02×10^{-18}J
D. 6.016×10^{-18} J

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

Clear selection

Question

A photon and an electron have the same wavelength then:

A. photon has greater momentum

B. electron has greater momentum

C. both have the same momentum

D. none of the above

- [ ] A.
- [ ] B.
- [x] C.
- [ ] D.

Clear selection

Question

Probability of finding a particle between 0 to $0.5L$ in a one-dimensional box of length L in the second excited state is :

Uncertainty principle states that the error in measurement is due to:

A. dual nature of particles

B. due to small size of particles

C. due to large size of particles

D. due to error in measuring instrument

- (selected) A.
- B.
- C.
- D.

The wavelength of a photon and the de-Broglie wavelength of an electron and uranium atom are identical. Which one of them will have highest kinetic energy

A. Electron

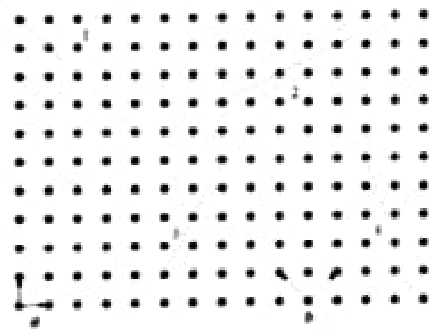
B. U-atom

C. Nothing can be predicted

D. Photon

- ○ A.
- ○ B.
- ○ C.
- ◉ D.

What will the Miller indices of the four sets of planes as shown in the following figure . Do this in the *a* coordinate system.



a- (1, 1), (1, $\bar{2}$), (2, $\bar{1}$) & (3, 1)

b- (1, 1), (2, $\bar{1}$), (2, 1) & (3, 1)

c- (1, 1), (1, $\bar{2}$), ($\bar{2}$, 1) & (3, 1)

d- (1, 2), (1, $\bar{2}$), (2, $\bar{1}$) & (2, 1)

- [ ] a
- [ ] b
- [x] c
- [ ] d

Clear selection

The density of atoms in (110) planes of fcc aluminum having lattice parameter 1 10 Å is

(a.) 1.72×10^{19} atoms/m^2

(b.) 1×10^{19} atoms/m^2

(c.) 1.72×10^{20} atoms/m^2

(d.) 1×10^{20} atoms/m^2

- ○ a
- ○ b
- ● c
- ○ d

Clear selection

The density of atoms in (110) planes of *fcc* aluminum having lattice parameter 1.10 Å is

(a.) 1.72×10^{19} atoms/m^2 (b.) 1×10^{17} atoms/m^2

(c.) 1.72×10^{20} atoms/m^2 (d.) 1×10^{20} atoms/m^2

- ○ a
- ○ b
- ◉ c
- ○ d

Clear selection

The wavefunction of a particle moving in a free space is given by $\Psi(x) = e^{ikx} + 2e^{-ikx}$. Then energy of the particle is -

(A) $5\hbar^2k^2/2m$

(B) $3\hbar^2k^2/4m$

(C) $\hbar^2k^2/2m$

(D) $3\hbar^2k^2/m$

- ○ a
- ○ b
- ◉ c

For lower value of wave vector k, the density of state of 3D energy-wave vector relation $E(K) = -\alpha - \gamma[\cos k_x a + \cos k_y a + \cos k_z a]$ **is-**

(a) $k/2\gamma\pi^2 a^2$

(b) $k/\gamma\pi^2 a^2$

(c) $k/4\gamma\pi^2 a^2$

(d) $k/3\gamma\pi^2 a^2$

- [ ] a
- [x] b
- [ ] c
- [ ] d

Clear selection

In a band structure calculation, the dispersion relation for electrons is found to be

$$E(K) = \beta[\cos k_x a + \cos k_y a + \cos k_z a]$$

Where β is a constant and a is the lattice constant. The effective mass at the boundary of the first Brillouin zone is

(A) $2\hbar^2/5\beta a^2$

(B) $4\hbar^2/5\beta a^2$

(C) $\hbar^2/2\beta a^2$

(D) $\hbar^2/3\beta a^2$

a

b

c

d

Clear selection

written as a Bloch function $\psi(x)e^{iqx}$, where $\psi(x)$ is periodic with the same period as the potential. Which one of the following differential equations is correct for $\psi(x)$?

(a) $\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q^2}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\psi = E\psi$

(b) $\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\psi = E\psi$

(c) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q}{m}\frac{d\psi}{dx} - \frac{\hbar^2 q^2}{2m}\psi + V(\dot{x})\psi = E\psi$

(d) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q^2}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\psi = E\psi$

- ○ a
- ◉ b
- ○ c
- ○ d

Clear select

Potassium chloride crystal has a density of $1.98 \times 10^{3}\, kg/m^{3}$ and its molecular weight is 74.55. The interatomic distance of the crystal is:

(a.) 6.3 Å (b.) 3.15 Å (c.) 3.3 Å (d.) 6.15 Å

- [ ] a
- [x] b
- [ ] c
- [ ] d

Clear selection

Aluminum is trivalent with atomic weight 27 and density $2.7 g/cm^3$, while the mean collision time between electrons is 4×10^{-14} s. Calculate the current flowing through an aluminum wire 20m long and $2mm^2$ cross-sectional area when a potential of 2V is applied to its ends-

(a) 60Å (b) 50.57Å (c) 45.42Å (d) 40.65Å

- ○ a
- ○ b
- ○ c
- ◉ d

Clear selection

If $\psi(x) = Aexp(-x^4)$ is the eigenfunction of a one-dimensional Hamiltonian with eigenvalue E = 0, the potential V(x) (in units where $\hbar = 2m = 1$) is

(A) $12x^2$

(B) $16x^6$

(C) $16x^6 + 12x^2$

(D) $16x^6 - 12x^2$

- ○ a
- ○ b
- ○ c
- ○ d

The nuclear potential that binds protons and neutrons in the nucleus of an atom is often approximated by a square well. Imagine a proton confined in an infinite square well of length 10^{-6} nm. So what will be the wavelength and energy associated with the photon that is emitted when the proton undergoes a transition from the first excited state $(n = 2)$ to the ground state $(n = 1)$?

a- $6.14\ MeV$ & $2.12 * 10^{-4} nm$

b- $614\ MeV$ & $2.02 * 10^{-6} nm$.

c- $5.14\ MeV$ & $2.12 * 10^{-5} nm$

d- $5.14\ MeV$ & $2.02 * 10^{-6} nm$

- ○ a
- ◉ b
- ○ c
- ○ d

Clear selection

In a band structure calculation, the dispersion relation for electrons is found to be

$$E(K) = \beta[\cos k_x a + \cos k_y a + \cos k_z a]$$

Where β is a constant and a is the lattice constant. The effective mass at the boundary of the first Brillouin zone is

(A) $2\hbar^2/5\beta a^2$

(B) $4\hbar^2/5\beta a^2$

(C) $\hbar^2/2\beta a^2$

(D) $\hbar^2/3\beta a^2$

- [ ] a
- [ ] b
- [ ] c
- [x] d

Clear

A particular metal has 10^{22} electrons per cubic meter. The Fermi energy at 0 K is

(a.) $1.7 \times 10^{-4}\ eV$ (b.) $1.7\ eV$ (c.) $2.7 \times 10^{-4}\ eV$

- ○ a
- ◉ b
- ○ c
- ○ d

Clear selec

A particular metal has $10^{[illegible]}$ electrons per cubic meter. The Fermi energy at 0 K is:

(a.) $1.7 \times 10^{-4}\, eV$ (b.) $1.7\, eV$ (c.) $2.7 \times 10^{-4}\, eV$ (d.) $2.7\, eV$

- a
- b
- c
- d

Clear selection

What is the drift velocity of free electrons if the 2A current is maintained in the conductor of the cross section 300 cm^2? Consider the free electron number density is $1 \times 10^{[illegible]} m^{-3}$

(a) $4.1\ m^2/V.s$

(b) $3.9\ m^2/V.s$

(c) $4.3\ m^2/V.s$

(d) $3.4\ m^2/V.s$

- (●) a
- ( ) b
- ( ) c
- ( ) d

Clear selection

In a Hall effect experiment on zinc, a potential of 4.5μV is developed across a foil of thickness 0.2mm when a current of 1.5A is passed in a direction perpendicular to a magnetic field of 2.0 T. The electron density of this zinc sample is-

(a) $2.08 \times 10^{28}/m^3$

(b) $2.08 \times 10^{29}/m^3$

(c) $2.08 \times 10^{27}/m^3$

(d) $2.08 \times 10^{30}/m^3$

- ○ a
- ◉ b
- ○ c
- ○ d

Clear selection

The wave function for the time independent Schrodinger equation with a periodic potential could be written as a Bloch function $\psi(x)e^{iqx}$, where $\psi(x)$ is periodic with the same period as the potential. Which one of the following differential equations is correct for $\psi(x)$?

(a) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q^2}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\,\psi = E\psi$

(b) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\,\psi = E\psi$

(c) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q}{m}\frac{d\psi}{dx} - \frac{\hbar^2 q^2}{2m}\psi + V(x)\,\psi = E\psi$

(d) $\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} - \frac{i\hbar^2 q^2}{m}\frac{d\psi}{dx} + \frac{\hbar^2 q^2}{2m}\psi + V(x)\,\psi = E\psi$

- a
- b
- c
- d

Assume that the crystal structure of metallic copper (Cu) results in a density of atoms $8.46 \times 10^{28}/m^3$. Each Cu atom in the crystal donates one electron to the conduction band, which leads for 3-D fermi gas to a density of states

$$g(E) = 1/2\pi^2 \left(2m^{*2}/\hbar^2\right)^{3/2} E^{1/2}$$

where m^* is the effective mass of the conduction electrons, In the low temperature limit (T=0k), find the fermi energy in units of eV. You may assume m^* to be equal to the free electrons mass m

(A) 7.05 eV

(B) 10.2 eV

(C) 9.7 eV

(D) 15.2 eV

- a
- b
- c
- d