“Particle in a Box”.

1. The walls of a particle in a box are supposed to be ____________
a) Small but infinitely hard
b) Infinitely large but soft
c) Soft and Small
d) Infinitely hard and infinitely large
View Answer
Answer: d
Explanation: The simplest quantum-mechanical problem is that of a particle in a box with infinitely hard walls and are infinitely large.

2. The wave function of the particle lies in which region?
a) $x > 0$
b) $x < 0$
c) $0 < X < L$
d) $x > L$
View Answer
Answer: c
Explanation: The particle cannot exist outside the box, as it cannot have infinite amount of energy. Thus, it’s wave function is between 0 and L, where L is the length of the side of the box.

3. The particle loses energy when it collides with the wall.
a) True
b) False
View Answer
Answer: b
Explanation: The total energy of the particle inside the box remains constant. It does not loses energy when it collides with the wall.

4. The Energy of the particle is proportional to __________
a) n
b) n^{-1}
c) n^2
d) n^{-2}
View Answer
Answer: c
Explanation: In a particle inside a box, the energy of the particle is directly proportional to the square of the quantum state in which the particle currently is.

5. For a particle inside a box, the potential is maximum at x = ___________
a) L

b) 2L
c) L/2
d) 3L
View Answer
Answer: a
Explanation: In a box with infinitely high barriers with infinitely hard walls, the potential is infinite when x = 0 and when x = L.

6. The Eigen value of a particle in a box is ___________
a) L/2
b) 2/L
c) $\sqrt{L/2}$
d) $\sqrt{2/L}$
View Answer
Answer: d
Explanation: The wave function for the particle in a box is normalizable, when the value of the coefficient of sin is equal to $\sqrt{2/L}$
. It is the Eigen value of the wave function.

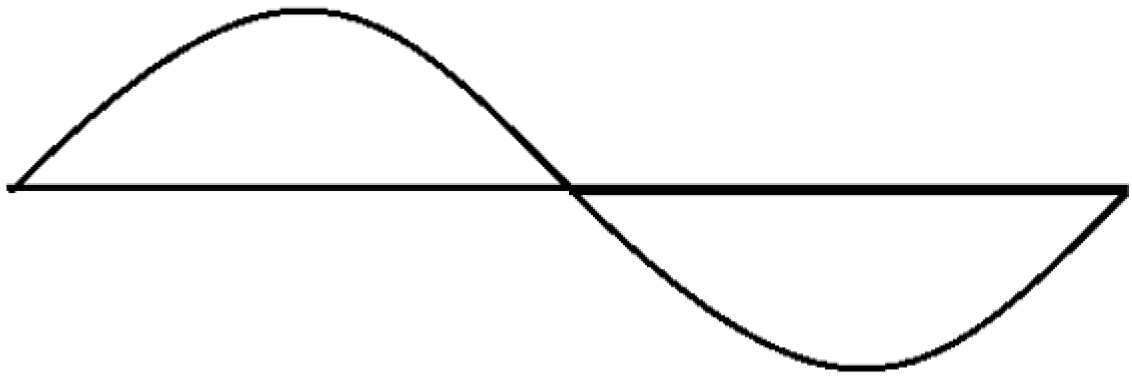
7. Particle in a box can never be at rest.
a) True
b) False
View Answer
Answer: a
Explanation: If the particle in a box has zero energy, it will be at rest inside the well and it violates the Heisenberg's Uncertainty Principle. Thus, the minimum energy possessed by a particle is not equal to zero.

8. What is the minimum Energy possessed by the particle in a box?
a) Zero
b) $\frac{\pi^2\hbar^2}{2mL^2}$
c) $\frac{\pi^2\hbar^2}{2mL}$
d) $\frac{\pi^2\hbar}{2mL}$
View Answer
Answer: b
Explanation: The minimum energy possessed by a particle inside a box with infinitely hard walls is equal to $\frac{\pi^2\hbar^2}{2mL^2}$. The particle can never be at rest, as it will violate Heisenberg's Uncertainty Principle.

9. The wave function of a particle in a box is given by ____________
a) $\sqrt{\frac{2}{L}}\sin\frac{nx}{L}$
b) $\sqrt{\frac{2}{L}}\sin\frac{n\pi x}{L}$
c) $\sqrt{\frac{2}{L}}\sin\frac{x}{L}$

d) $\sqrt{\frac{2}{L}} \sin\frac{\pi x}{L}$
View Answer
Answer: b
Explanation: The wave function for the particle in a box is given by: $\sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L}$.
The Energy possessed by the particle is given by: $\frac{n^2\pi^2\hbar^2}{2mL^2}$.

10. The wave function for which quantum state is shown in the figure?



a) 1
b) 2
c) 3
d) 4
View Answer
Answer: b
Explanation: The shown wave function is for the 2^{nd} principal quantum number, i.e., it is the wave function for the state when n = 2.

11. Calculate the Zero-point energy for a particle in an infinite potential well for an electron confined to a 1 nm atom.
a) 3.9 X 10^{-29} J
b) 4.9 X 10^{-29} J
c) 5.9 X 10^{-29} J
d) 6.9 X 10^{-29} J
View Answer
Answer: c
Explanation: Here, m = 9.1 X 10^{-31} kg, L = 10^{-9}m.
Therefore, E = $\frac{\pi^2\hbar^2}{2mL^2}$
= 3.14 X 3.14 X 1.05 X 1.05 X 10^{-68}/ 2 X 9.1 X 10^{-31} X 10^{-9}
= 5.9 X 10^{-29} J.

"PhotoElectric Effect".

1. During Einstein's Photoelectric Experiment, what changes are observed when the frequency of the incident radiation is increased?
a) The value of saturation current increases
b) No effect

c) The value of stopping potential increases
d) The value of stopping potential decreases
View Answer
Answer: c
Explanation: As the frequency of the incident radiation increases, the kinetic energies of the emitted electron increase as well and therefore requires more repulsive force to be applied to stop them. Thus, the stopping potential increases.
The value of saturation current increases, as the intensity of the incident radiation, increases.
The value of stopping potential decreases, as the frequency decreases.

2. What is the relation between the interaction parameter, 'b', and atomic radius, R, for the Photoelectric effect?
a) b > R
b) b ≈ R
c) b < R
d) no relation between b and R
View Answer
Answer: a
Explanation: If b > R, it means the interaction parameter is greater than the atomic radius. In this case, the electron is ejected by the photon and it is known as the Photoelectric effect.
If b ≈ R, the incident photons are scattered by the electron of the atom and the electron itself gets scattered. This phenomenon is known as the Compton effect.
If b < R, the photon is directly converted into an electron-positron pair, known as pair production.

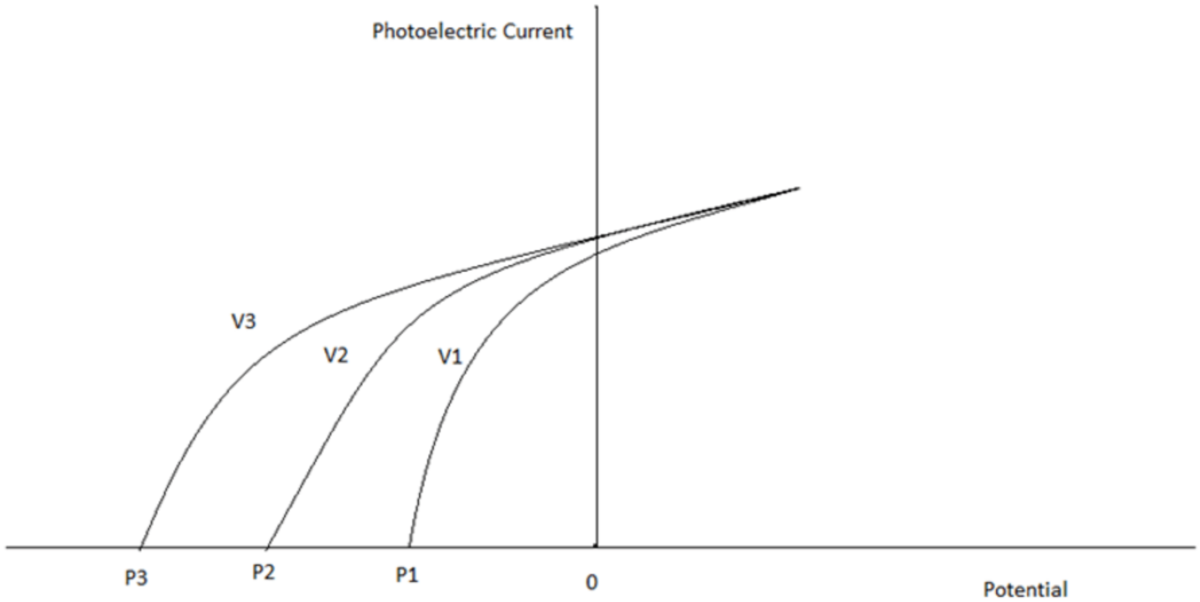
3. What is the time lag between the incidence of photons and the ejection of photoelectrons?
a) Greater than 10^{-5} s
b) Between 10^{-5} s and 10^{-9} s
c) Less than 10^{-9} s
d) 1 second
View Answer
Answer: c
Explanation: The laws of photoelectric emission states that it is an instantaneous process because the photoelectric emission occurs due to the elastic collision between a photon and an electron. Practically, there is no time lag (< 10^{-9} s) between the incident photon and emission of an electron.

4. How does the intensity affect the photoelectric current?
a) As intensity increases, the photoelectric effect increases

b) As the intensity increases, the photoelectric effect decreases
c) As the intensity decreases, the photoelectric effect becomes twice
d) No effect
View Answer
Answer: a
Explanation: Since each incident photon ejects one photoelectron from a metal surface, therefore, the number of photoelectrons emitted depends on the number of photons falling on the metal surface, which in turn depends on the intensity on the incident light.
Hence, as the intensity increases, the number of photoelectrons ejected increases and hence photoelectric current increases.

5. The photoelectric emission could be explained by the ___________
a) Wave nature of light
b) Particle nature of light
c) Dual nature of light
d) Quantum nature
View Answer
Answer: b
Explanation: The wave theory of light could not explain the laws of photoelectric emission. It was only by particle nature of light that Einstein was able to explain the photoelectric emission.
It was considered that when a photon of incident radiation collides with an electron, it transfers its energy to the electron, thus causing photoelectric emission.

6. Identify the correct order of frequencies.



a) $v_1 > v_2 > v_3$
b) $v_2 > v_3 > v_1$
c) $v_3 > v_2 > v_1$

d) $v_1 > v_3 > v_2$
View Answer
Answer: c
Explanation: As the frequency of the incident radiation increases, the potential required to stop the ejected electron (Stopping Potential) increases. Hence, $v_3 > v_2 > v_1$.
The stopping potential varies linearly with the frequency of the incident radiation.

7. The work function of lithium is 2.5 eV. The maximum wavelength of light that can cause the photoelectric effect in lithium is ______________
a) 3980 Å
b) 4980 Å
c) 5980 Å
d) 6980 Å
View Answer
Answer: b
Explanation: Work function, $\Phi_0 = hv_0$ or $hc\lambda_0$
Therefore, $\lambda_0 = hc\Phi_0$
Here, $\Phi_0 = 2.5$ eV = 2.5 X 1.6 X 10^{-19}J
Maximum Wavelength, $\lambda_0 = hc\Phi_0 = 4.98 \times 10^{-7}$ m
λ_0 = 4980 Å.

8. Light of wavelength 3500 Å is incident on two metals A and B. Which metal will yield more photoelectrons if their work functions are 5 eV and 2 eV respectively?
a) A
b) B
c) A & B
d) C
View Answer
Answer: b
Explanation: Here, λ = 3500 Å = 3.5 X 10^{-7}m
Energy of incident photons = $hv = hc\lambda$
= 3.536 eV
Since the work function of metal A is higher, it will not yield any photoelectrons. Hence, only metal B will yield photoelectrons.

9. The Kinetic energy of a photoelectron emitted on shining a light of wavelength 6.2 X 10^{-6} m on a metal surface of work function 0.1 eV is ________________
a) 0.01 eV
b) 0.02 eV
c) 0.1 eV
d) 1 eV
View Answer
Answer: c
Explanation: Kinetic Energy of photoelectrons = $hv - \Phi_0$

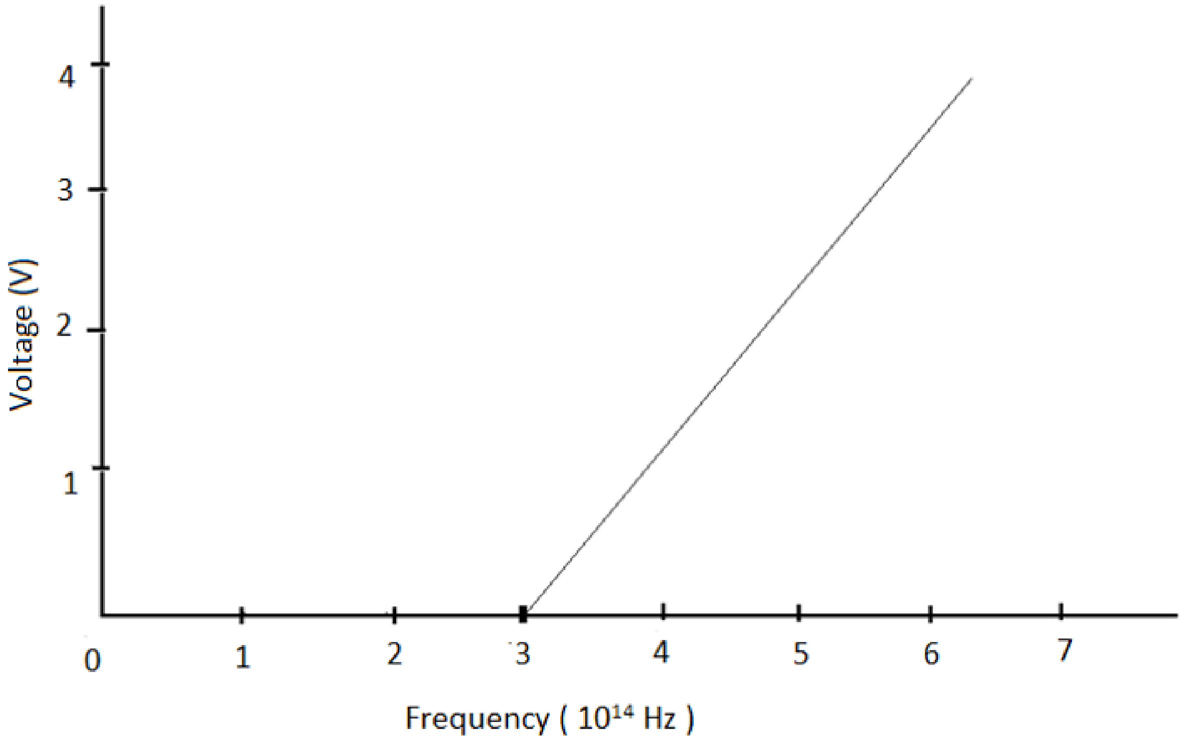
$= hc\lambda - \Phi_0$
Here, $\lambda = 6.2 \times 10^{-6}$m
$\Phi_0 = 0.1$ eV $= 1.6 \times 10^{-20}$J
$K_{max} = 3.2 \times 10^{-20}$J $- 1.6 \times 10^{-20}$J
$= 1.6 \times 10^{-20}$J
= 0.1 eV.

10. What is the effect of intensity on the stopping potential?
a) As intensity increases, stopping potential increases linearly
b) As intensity increases, stopping potential decreases linearly
c) As intensity decreases, stopping potential increases exponentially
d) No effect
View Answer
Answer: d
Explanation: Changing the intensity of incident radiation does not affect the stopping potential. As the intensity increases, the number of photoelectrons ejected increases. However, the maximum velocity attained by them remains independent of the intensity of the radiation. It only depends on the frequency of the incident radiation.

11. Which of the following gases are filled inside the Photoelectric cells?
a) Carbon Dioxide
b) Nitrogen
c) Neon
d) Oxygen
View Answer
Answer: c
Explanation: Inert gases like neon or argon are filled inside the photoelectric cells to increase the photoelectric current due to ionization. When the potential difference between the two electrodes exceeds the ionization potential of the gas, the emitted photoelectrons ionize the gas which increases the magnitude of the current.

12. On which part of the photoelectric cell does the radiation strikes?
a) Cathode
b) Anode
c) Ammeter
d) Radiation does not strike on the photoelectric cell
View Answer
Answer: a
Explanation: The radiation strikes on the photosensitive plate which is used as a cathode. When radiation falls on the plate, photoelectrons are ejected which are accelerated towards charged plate A. This completes the circuit and the current flows.

13. For the photoelectric effect in sodium, the figure shows the plot of cut-off voltage versus frequency of incident radiation. The threshold frequency is __________



a) 6.5 X 10^{14} Hz
b) 4.5 X 10^{14} Hz
c) 3 X 10^{14} Hz
d) 5 X 10^{14} Hz
View Answer
Answer: c
Explanation: The threshold frequency corresponds to the frequency for which the cut-off voltage is zero. Hence, the threshold frequency for sodium, as observed in the graph, is 3 X 10^{14} Hz.

“Wave Nature of Matter”.

1. What type of nature do electromagnetic waves have?
a) Dual nature
b) Wave nature
c) Particle nature
d) Photon nature
View Answer
Answer: a
Explanation: Electromagnetic radiations have a wave nature as well as properties alike to those of particles. Therefore, electromagnetic radiations are emissions with a dual nature, i.e. it has both wave and particle aspects.

2. The magnitude of which of the following is proportional to the frequency of the wave?
a) Electrons
b) Neutrons

c) Photons
d) Protons
View Answer
Answer: c
Explanation: The energy conveyed by an electromagnetic wave is always carried in packets whose magnitude is proportional to the frequency of the wave. These packets of energy are known as photons. The energy of a photon is given as:
$E = hv$
Where h is the Planck's constant and v is the frequency of the wave.

3. Identify the de – Broglie expression from the following.
a) $\lambda=h\times p$
b) $\lambda=hp$
c) $\lambda=h+p$
d) $\lambda=h-p$
View Answer
Answer: b
Explanation: de – Broglie equation states that matter can act as waves as well as particles. So, the de Broglie equation helps us understand the concept of matter having a wavelength. The expression for de – Broglie wavelength is given as:
$\lambda=hp=hmv$
Where h is the Planck's constant; p is the momentum; m is the mass of the particle and v is the velocity of the particle.

4. When the wavelength of an electron increases, the velocity of the electron will also increase.
a) True
b) False
View Answer
Answer: b
Explanation: No, this is a false statement. According to the de – Broglie equation, the velocity of the particle and the de – Broglie are inversely proportional to each other. Therefore, when the wavelength of an electron increases, the velocity of the electron decreases.

5. The sun gives light at the rate of 1500 W/m^2 of area perpendicular to the direction of light. Assume the wavelength of light as 5000Å. Calculate the number of photons/s arriving at 1 m^2 area at that part of the earth.
a) 4.770×10^{21}
b) 3.770×10^{11}
c) 3.770×10^{21}
d) 3.770×10^{20}
View Answer

Answer: c
Explanation: Given: I = 1500 W/m^2; Wavelength = 5000Å
Required equation ➔ E=hv=hcλ
Speed of light (c) = 3 × 10^8 m/s
Number of photons/s received = n = IAE=(1500×1)×(5000×10-10)6.63×10-34×3×108
n = 3.770 × 10^{21}
Therefore, the number of electrons received per second is 3.770 × 10^{21}.

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6. What is the de – Broglie wavelength associated with an electron, accelerated through a potential difference of 200 volts?
a) 1 nm
b) 0.5 nm
c) 0.0056 nm
d) 0.086 nm
View Answer
Answer: d
Explanation: Given: Potential difference (V) = 200 V
The de – Broglie wavelength is given as:
λ=hp=hmv=1.227V√ nm
λ=1.227200√
λ=0.086 nm

7. What is the de – Broglie wavelength of a proton accelerated through a potential difference of 2 kV?
a) 0.65 × 10^{-13} m
b) 0.65 × 10^{-10} m
c) 0.65 × 10^{-11} m
d) 0.65 × 10^{-20} m
View Answer
Answer: b
Explanation: Given: charge of proton = 1.6 × 10^{-19}; mass of proton = 1.6 × 10^{-27}; V = 2 kV
λ=hp=h2mE√=h2mqV√
λ=6.6×10-342×(1.6×10-27)×(1.6×10-19)×2000√
λ=0.65 × 10^{-12} m
Therefore, the wavelength is 0.65 × 10^{-12} m.

8. While comparing the alpha particle, neutron, and beta particle, the alpha particle has the lowest de – Broglie wavelength.
a) True
b) False
View Answer
Answer: a
Explanation: Yes, this is a true statement. In comparison with beta particle and

neutron, the alpha particle has a higher mass, followed by neutron and then beta particle. According to de – Broglie wavelength equation, the wavelength is inversely proportional to the mass. Hence, the alpha particle has the lowest wavelength since it has the highest mass.

9. What is the de – Broglie wavelength of a ball of mass 150 g moving at a speed of 50 m/s?
a) 8.8×10^{-34} m
b) 8.8×10^{-30} m
c) 8.8×10^{-25} m
d) 8.8×10^{-35} m
View Answer
Answer: d
Explanation: Given: m = 150 g; v = 50 m/s
The required equation ➔ $\lambda=\frac{h}{p}=\frac{h}{mv}$
$\lambda=\frac{6.6\times10^{-34}}{150\times10^{-3}\times50}$
$\lambda=8.8 \times 10^{-35}$ m

10. What will be the de – Broglie wavelength when the kinetic energy of the electron increases by 5 times?
a) √5
b) 5
c) $\frac{1}{\sqrt{5}}$
d) $\frac{1}{5}$
View Answer
Answer: c
Explanation: The required equation ➔ $\lambda=\frac{h}{mv}=\frac{h}{\sqrt{2mK}}$
Where h is the Planck's constant, m is the mass of the electron and K is the kinetic energy of the electron.
Since the mass of the electron remain unchanged, the wavelength will be inversely proportioned to the kinetic energy, so,
$\frac{\lambda}{\lambda'}=\sqrt{\frac{K'}{K}}=\sqrt{\frac{5K}{K}}$ = √5
Therefore, $\lambda'=\frac{\lambda}{\sqrt{5}}$
Hence, the wavelength is reduced by a factor of √5

"Davisson and Germer Experiment".

1. Which theory is confirmed by the Davisson – Germer experiment?
a) de – Broglie theory
b) Newton's theory
c) Einstein's theory
d) Planck's theory
View Answer
Answer: a
Explanation: Davisson and Germer experiment proves the concept of wave nature

of matter particles. The Davisson–Germer experiment provides a critically important confirmation of the de-Broglie hypothesis, which said that particles, such as electrons, are of dual nature.

2. Which of the following is used in the Davisson – Germer experiment?
a) Double slit
b) Single slit
c) Electron gun
d) Electron microscope
View Answer
Answer: c
Explanation: Davisson – Germer experiment uses an electron gun to produce a fine beam of electrons which can be accelerated to any desired velocity by applying a suitable voltage across the gun. The others mentioned do not find an application here.

3. Which crystal is used in the Davisson – Germer experiment?
a) Aluminum
b) Nickel
c) Cobalt
d) Zinc
View Answer
Answer: b
Explanation: The crystal used in the Davisson – Germer experiment is nickel. A fine beam of electrons is made to fall on the surface of the nickel crystal. As a result, the electrons are scattered in all directions by the atoms of the crystal.

4. Intensity is different for different angles of scattering in the Davisson – Germer experiment.
a) True
b) False
View Answer
Answer: a
Explanation: Yes, this statement is true. When the graphs are drawn showing the variation of intensity of the scattered electrons with the angles of scattering at different accelerating voltages, it is found that the intensity is different for different angles of scattering.

5. Identify the expression for Bragg's law from the following.
a) $2d \cos\theta = n\lambda$
b) $2d \sin\theta = n\lambda$
c) $2d \sin\theta = n\lambda$

d) $2d \cos\theta = n\lambda$

View Answer

Answer: b

Explanation: Bragg's law is a special case of Laue diffraction, it gives the angles for coherent and incoherent scattering from a crystal lattice. The expression for Bragg's law is given as:

$2d \sin\theta = n\lambda$

"Compton Effect".

1. Which of the following is the characteristic of a black body?
a) A perfect absorber but an imperfect radiator
b) A perfect radiator but an imperfect absorber
c) A perfect radiator and a perfect absorber
d) A perfect conductor

View Answer

Answer: c

Explanation: When the radiations are made to pass through a black body, it undergoes multiple reflections and is completely absorbed. When it is placed in a temperature bath of fixed temperature, the heat radiations will come out. Thus a black body is a perfect absorber and a perfect reflector.

2. The energy distribution is not uniform for any given temperature in a perfect black body.
a) True
b) False

View Answer

Answer: a

Explanation: At different temperatures, when a perfect black body is allowed to emit radiations, then the distribution of energy for different wavelengths at various temperatures is not uniform.

3. Rayleigh-Jean's law holds good for which of the following?
a) Shorter wavelength
b) Longer wavelength
c) High temperature
d) High energy

View Answer

Answer: b

Explanation: According to this law, the energy distribution is directly proportional to the absolute temperature and is inversely proportional to the fourth power of the wavelength. Therefore longer the wavelength, greater is the energy distribution.

4. Wien's displacement law holds good only for shorter wavelength.
a) False
b) True
View Answer
Answer: b
Explanation: This law states that, the product of the wavelength, corresponding to maximum energy and the absolute temperature, is constant. If ʎ is less, then 1/ʎ will be great. Therefore $e^{(hc/ʎKT)}$ will be great.

5. Which of the following does not affect the photon?
a) Magnetic or electric field
b) Light waves
c) Gravity
d) Current
View Answer
Answer: a
Explanation: Photons have no charge. They can interact with charged particles but not with themselves. This is why photons are neutral and not affected by magnetic or electric fields.

6. What is Compton shift?
a) Shift in frequency
b) Shift in charges
c) Shift in radiation
d) Shift in wavelength
View Answer
Answer: d
Explanation: When a photon collides with an electron at rest, the photon gives its energy to the electron. Therefore the scattered photon will have higher wavelength compared to the wavelength of the incident photon. This shift in wavelength is called Compton shift.

7. Compton shift depends on which of the following?
a) Incident radiation
b) Nature of scattering substance
c) Angle of scattering
d) Amplitude of frequency
View Answer
Answer: c
Explanation: From the theory of Compton effect it is deducted that change in wavelength
Δʎ = h/mc (1-cosɵ). This equation shows that the change in wavelength is

independent of the incident radiation as well as the nature of scattering substance. The shift depends only on the angle of scattering.

8. Which of the following is called as non-mechanical waves?
a) Magnetic waves
b) Electromagnetic waves
c) Electrical waves
d) Matter waves
View Answer
Answer: b
Explanation: The waves which travel in the form of oscillating electric and magnetic waves are called electromagnetic waves. Such waves do not require any material for their propagation and are called non-mechanical waves.

9. Which of the following is associated with an electron microscope?
a) Matter waves
b) Electrical waves
c) Magnetic waves
d) Electromagnetic waves
View Answer
Answer: a
Explanation: The waves associated with microscopic particles when they are in motion are called matter waves. Electron microscope makes use of the matter waves associated with fast moving electrons.

10. A radio station broadcasts its programme at 219.3 metre wavelength. Determine the frequency of radio waves if velocity of radio waves is 3×10^{8} m/s.
a) 7.31×10^{-7} Hz
b) 1.954×10^{-6} Hz
c) 1.368×10^{6} Hz
d) 6.579×10^{10} Hz
View Answer
Answer: c
Explanation: ʎ = velocity/frequency
Frequency = velocity/ʎ
Therefore, frequency = 1.368×10^{6} Hz.

11. Calculate the de-Broglie wavelength of an electron which has been accelerated from rest on application of potential of 400volts.
a) 0.1653 Å
b) 0.5125 Å
c) 0.6135 Å
d) 0.2514 Å
View Answer
Answer: c
Explanation: de-Broglie wavelength = $h/\sqrt{(2\times m\times e\times V)}$

De-Broglie wavelength = $(6.625\times10^{-14})/\sqrt{(2\times9.11\times10^{-31}\times1.6\times10^{-19}\times400)}$
Wavelength = 0.6135 Å.

"Waves".

1. When a pebble is dropped into a pond of still water, what happens?
a) Particles move
b) Waves move
c) The pebble moves
d) Water moves
View Answer
Answer: b
Explanation: When a pebble is thrown in still water, a circular pattern of alternate crests spread out. The kinetic energy makes the particles to oscillate which comes in contact with it. The energy gets transferred to the particles of the next layer which also begins to oscillate. Thus it is the disturbance or waves that move forward and not the particles of the medium.

2. Mechanical waves are called elastic waves.
a) True
b) False
View Answer
Answer: a
Explanation: Waves which require a medium for their propagation are called mechanical waves. They are also called elastic waves because they depend on the elastic properties of a medium.

3. What are the essential properties a medium must possess for the propagation of mechanical waves?
a) Stable pressure
b) Maximum friction
c) Constant temperature
d) Minimum friction
View Answer
Answer: d
Explanation: The friction force amongst the particles of the medium should be negligibly small so that they continue oscillating for a sufficiently long time and the wave travels a sufficiently long distance through the medium

4. Transverse waves can be formed in fluids.
a) True

b) False
View Answer
Answer: b
Explanation: Transverse waves travel in the form of crests and troughs. They involve changes in the shape of the medium. So they can be transmitted through media which have rigidity. As fluids do not sustain shearing stress, transverse waves cannot be formed in them.

5. Which of the following waves can be transmitted through solids, liquids and gases?
a) Transverse waves
b) Electromagnetic waves
c) Mechanical waves
d) Longitudinal waves
View Answer
Answer: d
Explanation: Longitudinal waves involve changes in the volume and density of the medium. Since all media can sustain compressive stress, longitudinal waves can be transmitted through all the three types of media.

6. For an aluminium the modulus of rigidity is 2.1×10^{10} N/m^2 and density is 2.7×10^3 kg/m^3. Find the speed of transverse waves in the medium.
a) 27.9×10^3 m/s
b) 2.79×10^3 m/s
c) 25.14×10^3 m/s
d) 24.1×10^3 m/s
View Answer
Answer: b
Explanation: Speed = $\sqrt{(\eta/\rho)}$
Speed = 2.79×10^3 m/s.

7. Sound travels through a gas under which of the following condition?
a) Isothermal condition
b) Non-isothermal condition
c) Adiabatic condition
d) Transverse condition
View Answer
Answer: c
Explanation: The compressions and rarefactions are formed so rapidly that the heat generated in the regions of compressions does not get time to pass into the regions of rarefactions so as to equalize the temperature. So when sound travels through gas, the temperature remains constant. Therefore, it is adiabatic.

8. What kind of wave is formed in organ pipes?
a) Transverse stationary waves
b) Electromagnetic waves
c) Mechanical waves
d) Longitudinal stationary waves
View Answer
Answer: d
Explanation: When two identical longitudinal waves travelling in opposite directions overlap, a longitudinal stationary wave is formed. Thus, the waves produced in organ pipes are longitudinal stationary waves.

9. A wave transmits momentum. Can't it transfer angular momentum?
a) Yes
b) No
View Answer
Answer: b
Explanation: A wave transmitting momentum cannot transmit angular momentum because a transfer of angular momentum means the action of a torque which causes rotator motion.

10. What is the most fundamental property of wave?
a) Temperature
b) Pressure
c) Frequency
d) Wavelength
View Answer
Answer: c
Explanation: When a wave travels from one medium to other, its wavelength as well as velocity may change. This is the reason that frequency is the fundamental property of a wave.

11. Which of the following is also known as pressure waves?
a) Transverse waves
b) Longitudinal waves
c) Mechanical waves
d) Stationary waves
View Answer
Answer: b
Explanation: Longitudinal waves travel in a medium as series of alternate compressions and rarefactions and hence are called pressure waves.

12. In which medium sound travels faster?
a) Solid
b) Liquid
c) Gas

d) Water vapour
View Answer
Answer: a
Explanation: Sound travels in solid with the highest speed because the coefficient of elasticity of solids is much greater than the coefficient of elasticity of liquids and gases.

"Black Body Radiation".

1. As the wavelength of the radiation decreases, the intensity of the black body radiations ____________
a) Increases
b) Decreases
c) First increases then decrease
d) First decreases then increase
View Answer
Answer: c
Explanation: In the case of Black Body radiations, as the body gets hotter the wavelength of the emitted radiation decreases. However, the intensity first increases up to a specific wavelength than starts decreasing, as the wavelength continues to decrease.

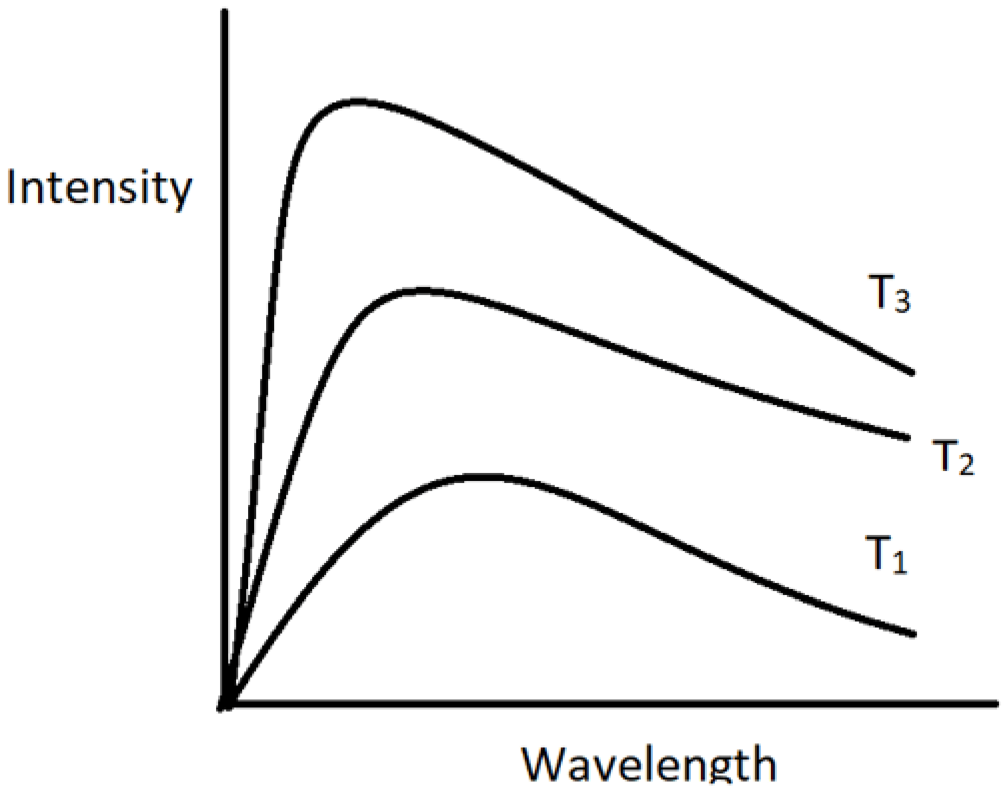
2. The radiations emitted by hot bodies are called as ________________
a) X-rays
b) Black-body radiation
c) Gamma radiations
d) Visible light
View Answer
Answer: b
Explanation: The phenomenon of black—body radiations was given by Max Planck. He stated that hot bodies emit radiation over a wide range of wavelengths. An ideal body is the one that emits and absorbs radiation of all frequencies. Such a body called a Black Body and the radiations are called Black body radiations.

3. An iron rod is heated. The colors at different temperatures are noted. Which of the following colors shows that the iron rod is at the lowest temperature?
a) Red
b) Orange
c) White
d) Blue
View Answer
Answer: a
Explanation: As the body gets hotter, the frequency of the emitted radiation keeps on increasing. Blue color has the highest frequency out of red, orange and white.

Thus, as the iron rod gets heated first it would become red, then orange, then white and then finally blue.

4. A black body is defined as a perfect absorber of radiations. It may or may not be a perfect emitter of radiations.
a) True
b) False
View Answer
Answer: b
Explanation: A black body is defined as the one which is a perfect absorber as well as a perfect emitter of radiations. Such a body would absorb all the radiations falling on it and would emit all of them when heated.

5. From the figure, what's the relation between T_1, T_2, and T_3?



a) $T_1 > T_2 > T_3$
b) $T_3 > T_2 > T_2$
c) $T_3 > T_1 > T_2$
d) $T_2 > T_1 > T_3$
View Answer
Answer: b
Explanation: We already know, as the temperature of the body is higher, the intensity of the black body radiations would be higher. Thus, from the graph, the

radiations with temperature T_3 has the highest intensity followed by the one with temperature T_2 and then T_1. Thus, $T_3 > T_2 > T_1$.

6. Electromagnetic wave theory of light could not explain Black Body radiations.
a) True
b) False
View Answer
Answer: a
Explanation: According to electromagnetic theory, the absorption and the emission should be continuous. As the wavelength keeps decreasing, the intensity of the emitted radiations should keep increasing to infinity. Such is not the case with Black Body Radiations.

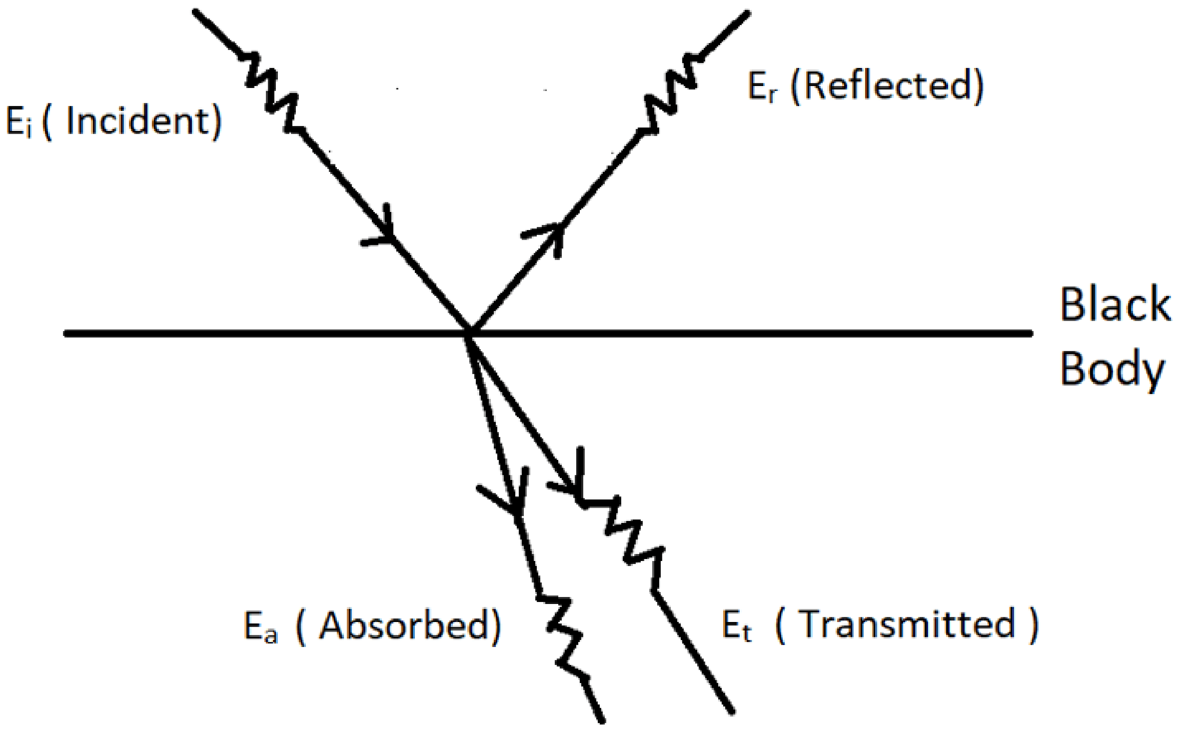
7. The unit of absorptive power is _______________
a) T
b) Ts^{-1}
c) Ts
d) No unit
View Answer
Answer: d
Explanation: Absorptive power can be defined as the ratio of energy absorbed per unit area upon energy incident per unit time per unit area. For a black body, it's absorptive power is equal to one.

8. For an object other than a black body, it's emissivity, e is _______________
a) 1
b) $0 < e < 1$
c) $e > 1$
d) $e = 0$
View Answer
Answer: b
Explanation: Emissivity is the ratio of emissive power of any object and the emissive power of the black body having the same temperature and surface area as the object. Thus, for a black body, it is equal to 1. For any other object, it is less than 1.

9. What relation between emissivity, e, and Absorptive Power, a, is given by Kirchhoff's law?
a) $e < a$
b) $e > a$
c) $e = a$
d) no specific relation
View Answer

Answer: c
Explanation: Kirchhoff's law states that for any object the emissivity is always equal to absorptive power. For a black body, both of them are equal to one.

10. What is the relation between the Energies as shown in the figure?



a) $E_r = 0$
b) $E_a = 0$
c) $E_t = E_i$
d) $E_i = E_r$
View Answer
Answer: a
Explanation: As a black body is a perfect absorber, the reflected energy and the transmitted energy should be zero. Also, the energy of the incident radiation should be equal to the energy absorbed.

"Quantum Nature of Elastic Waves".

1. Elastic waves in crystals are made up of _______________
a) Photons
b) Nano particles
c) Atoms
d) Phonons
View Answer
Answer: d
Explanation: In a crystal, when energy is provided, the lattice absorbs energy and

gets excited to a higher state. When it de-excites to ground state, it releases radiation in sound-wave region, known as phonons. These waves are quantized.

2. The energy of elastic waves is given by ____________
a) nω
b) n ħω
c) nħω/2
d) (n + ½)ħω
View Answer
Answer: d
Explanation: The energy of a lattice vibration is quantized which is given by the expression: E = (n + ½)ħω, where w is the angular frequency of the waves.

3. Waves in the wave packets are such that they interfere constructively over a large region of space.
a) True
b) False
View Answer
Answer: b
Explanation: A wave packet consists of a group of waves, each of which have phases and amplitudes such that they interfere constructively over a small region of space where the particle can be located. Outside that region, they interfere destructively.

4. Which of the following is the correct expression for the group velocity?
a) υλ
b) dω/dυ
c) dE/dk
d) dE/ħdk
View Answer
Answer: d
Explanation: The velocity with which the wave packet moves is called the group velocity. It is equal to dω/dk, which can be further simplified to dE/ħdk, as E =ħω.

5. Which of the following is the correct relation between the group velocity and the phase velocity?
a) $v_g = v_p + \lambda dv_p/d\lambda$
b) $v_p = v_g + \lambda dv_p/d\lambda$
c) $v_p = v_g - \lambda dv_p/d\lambda$
d) $v_g = v_p - \lambda dv_p/d\lambda$
View Answer

Answer: d
Explanation: The relation between the phase velocity and the group velocity is given by: $v_g = v_p - \lambda dv_p/d\lambda$. Thus, when $dv_p/d\lambda = 0$, $v_g = v_p$.

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6. The motion of a wave packet is similar to ____________
a) Photons
b) Waves
c) Classical Particle
d) Quantum Particle
View Answer
Answer: c
Explanation: The motion of a material/classical particle is equivalent to a group of waves or a wave packet. Such an expression can be derived by using the basic principles of motion.

7. Which of the following is not a characteristic of wave function?
a) Continuous
b) Single valued
c) Differentiable
d) Physically Significant
View Answer
Answer: d
Explanation: The wave function has no physical significance. It merely helps in determining the state of a particle. It is the square of the wave function that has a physical significance.

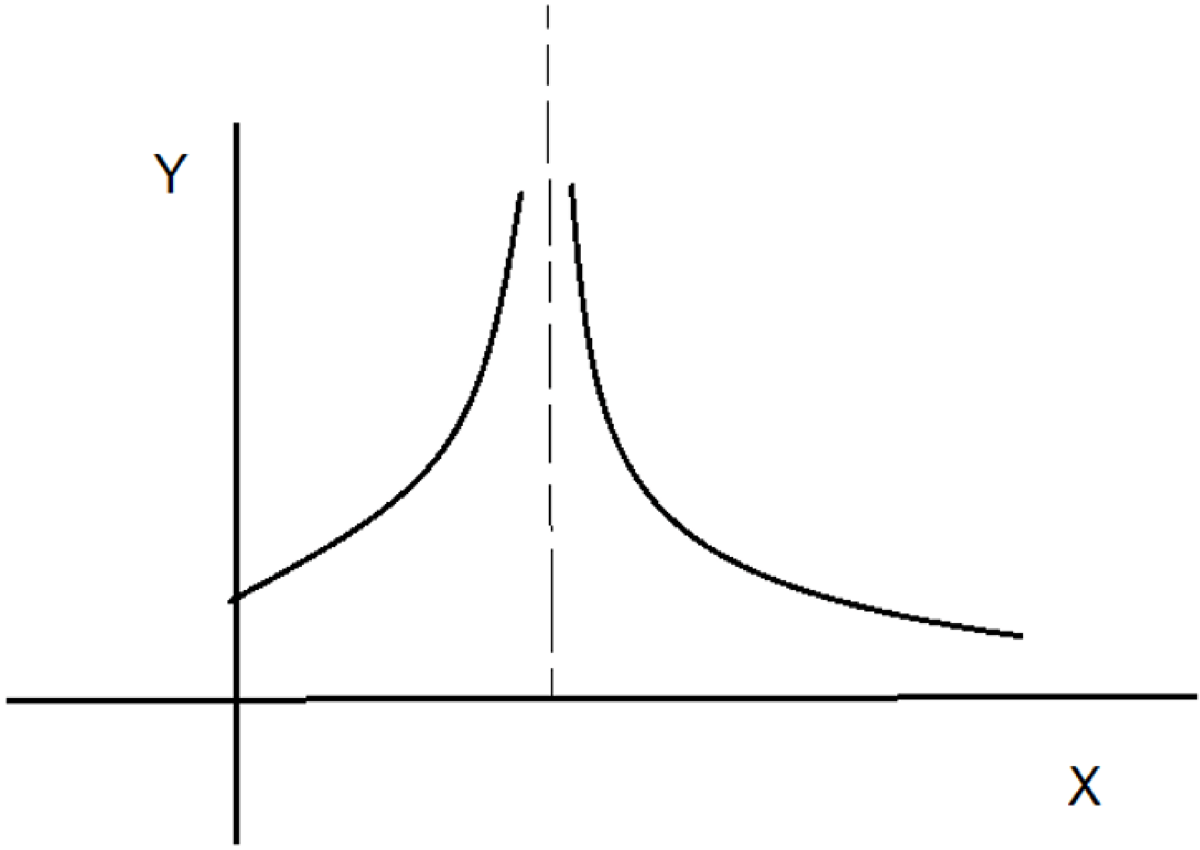
8. There is an inextensible string of linear density μ. If it is given that ω = kTμ−−√, then what is the group velocity of the string?
a) Tμ−−√
b) ħTμ−−√
c) ℏ2Tμ−−√
d) 1ℏTμ−−√
View Answer
Answer: a
Explanation: As we know, $v_g = d\omega/dk$
Therefore, v_g = d(kTμ−−√)/dk
= Tμ−−√.

9. Ψ must be normalizable.
a) True
b) False
View Answer

Answer: a
Explanation: Ψ must fo to 0 as x-> infinity, y-> infinity and z -> infinity in order that $\int|\Psi|^2$ dv all over space be a finite constant. Thus, Ψ must be normalizable.

10. Calculate the minimum uncertainty in the momentum of a 4He atom confined to 0.40 nm.
a) 2.02×10^{-25} kg m/s
b) 2.53×10^{-25} kg m/s
c) 2.64×10^{-25} kg m/s
d) 2.89×10^{-25} kg m/s
View Answer
Answer: c
Explanation: We know that 4He atom is somewhere in the 0.40 nm region, therefore, Δx = 0.40 nm.
Using, $\Delta p_x \geq \hbar \Delta x$
For minimum uncertainty, $\Delta p_x = 6.626 \times 10^{-34}$ Js/2π X 0.40×10^{-9}
= 2.64×10^{-25} kg m/s.

11. The following is a possible wave function.



a) True
b) False
View Answer

Answer: b
Explanation: The following cannot be the graph of a wave function as the graph is discontinuous. A wave function should be continuous and single valued.

12. The uncertainty in the location of a particle moving with velocity 7.28 X 10^7m /s is two times its de-Broglie wavelength. What is the uncertainty in measuring the velocity?
a) 5.79 X 10^6 m/s
b) 6.12 X 10^6 m/s
c) 7.63 X 10^6 m/s
d) 8.45 X 10^6 m/s
View Answer
Answer: a
Explanation: De-Broglie wavelength, $\lambda = h/mv$
Given: $\Delta x = 2\lambda = 2h/mv$
Now, $\Delta x.m.\Delta v = \hbar$
$\Delta v = v/4\pi$
= 5.79 X 10^6 m/s.

13. Energy of a wave divided by its momentum gives _____________
a) Group velocity
b) Classical Velocity
c) Phase Velocity
d) Wave velocity
View Answer
Answer: d
Explanation: We know, $E = \hbar\omega$ and $P = \hbar k$. Therefore, E/P gives us w/k which is the phase velocity of the wave. Hence, Energy of a wave divided by its momentum gives us phase velocity.

14. Which of the following can be a wave function?
a) tan x
b) sin x
c) cot x
d) sec x
View Answer
Answer: b
Explanation: Out of all the given options, sin x is the only function, that is continuous and single-valued. All the rest of the functions are either discontinuous or double-valued.

15. At what condition, $v_p = v_g$?
a) $dv_p/dk = 0$
b) $dv_p/d\omega = 0$
c) $dv_p/d\lambda = 0$

d) $dv_p/d\mu = 0$
View Answer
Answer: c
Explanation: As we know, the relation between the phase and group velocity is $v_g = v_p - \lambda dv_p/d\lambda$. Thus, as $dv_p/d\lambda = 0$, $v_p = v_g$.

"Quantum Number".

1. Quantum Numbers are solutions of ____________
a) Heisenberg's Uncertainty Principle
b) Einstein's mass energy relation
c) Schrodinger's Wave Equation
d) Hamiltonian Operator
View Answer
Answer: c
Explanation: When the wave function for an atom is solved using the Schrodinger Wave Equation, the solutions obtained are called the Quantum Number which are basically n, l and m.

2. Which quantum numbers gives the shell to which the electron belongs?
a) n
b) l
c) m
d) s
View Answer
Answer: a
Explanation: The principal quantum number, n, gives the shell to which the electron belongs. The energy of the shell is dependent on 'n'.

3. What is the maximum number of electrons in a shell?
a) n
b) 2n
c) n^2
d) $2n^2$
View Answer
Answer: d
Explanation: The total number of electrons in a shell are given by: $2n^2$ while the number of orbitals present in a shell is given by n^2, which is half the total number of electrons in that shell.

4. Which of the following is the correct expression for the orbital angular momentum?
a) l+1−−−−√

b) $\sqrt{n(l+1)}$
c) $\sqrt{l(l+1)}$
d) $\sqrt{m(l+1)}$
View Answer
Answer: c
Explanation: The orbital angular momentum of an electron is given by the expression: $\sqrt{l(l+1)}$. Thus, when the azimuthal quantum number, l, is zero the angular momentum is zero as well.

5. Which of the following quantum number gives the shape of atomic orbital of sub-shell?
a) n
b) l
c) m
d) s
View Answer
Answer: b
Explanation: The Azimuthal quantum number, l, helps in determining the shape of the atomic orbital of sub-shell. It also gives the sub-shell to which the electron belongs.

6. What is the range of Azimuthal Quantum Number, l?
a) 0 to n
b) 0 to s
c) 0 to n-1
d) 0 to s-1
View Answer
Answer: c
Explanation: The value of Azimuthal Quantum number, l, varies from 0 to n-1. It helps us in identifying to which subshell the electron belongs.

7. The total value of the magnetic quantum number are _______________
a) 2n
b) 2l
c) 2n + 1
d) 2l + 1
View Answer
Answer: d
Explanation: The magnetic quantum number denotes the orientation of electrons in an atom. The total values of m_e are 2l + 1. They vary from –l to +l.

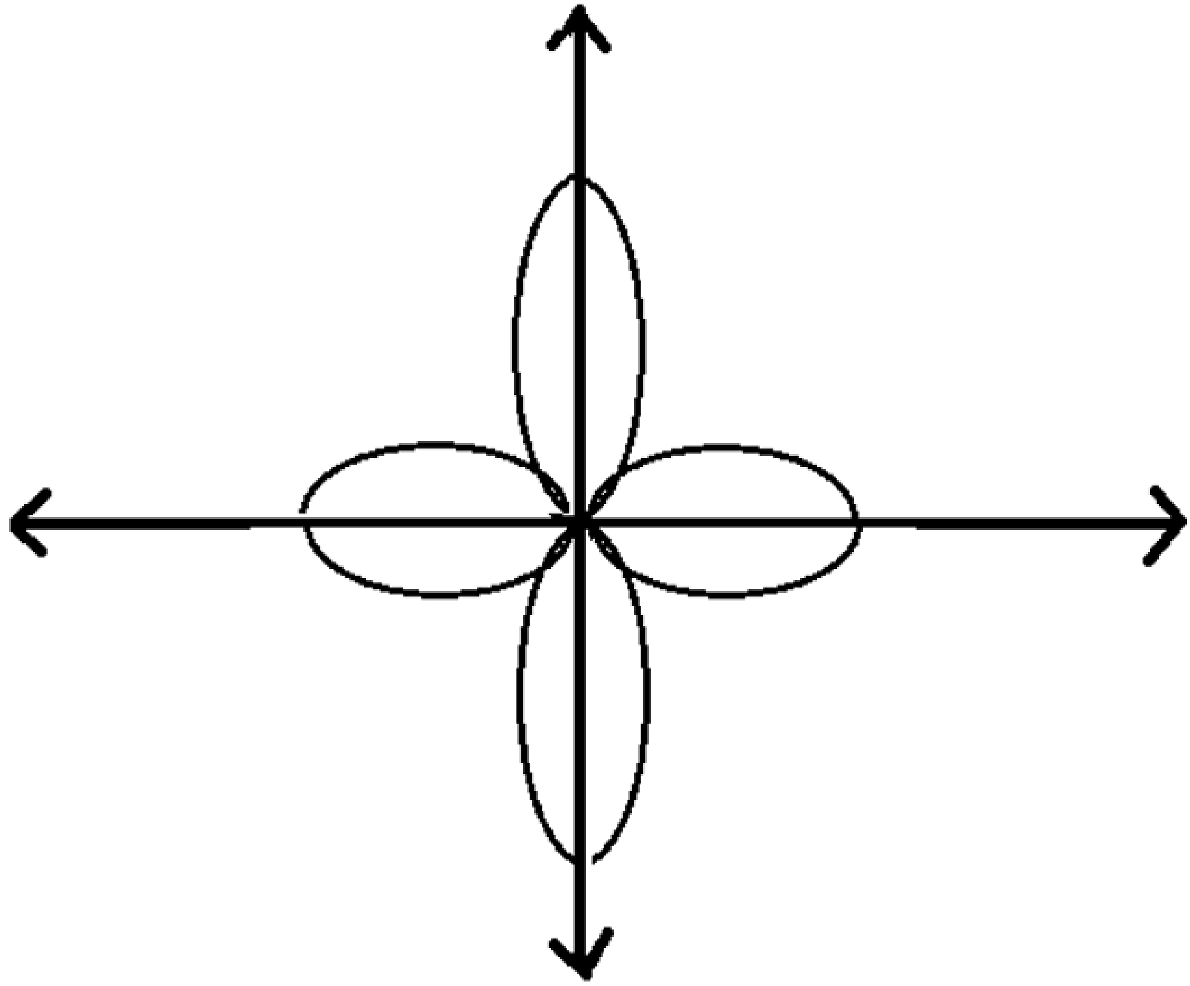
8. How many values does the spin quantum number have?
a) 2
b) 2l

c) 2n
d) $2m_e$
View Answer
Answer: a
Explanation: The spin quantum number have only two values: +1/2 and -1/2. It is not a solution of the Schrodinger wave equation.

9. Which of the following can be the quantum numbers for an orbital?
a) n = 4, l = 4, m = 3
b) n = 2, l = 3, m = 1
c) n = 3, l = 2, m = -1
d) n = 3, l = 0, m = -3
View Answer
Answer: c
Explanation: In the given options, option c is the correct option because in this the value of l is between 0 – n-1 and value of m is between –l to +l.

10. An electron makes a transition from n = 5 state to n = 2 state in the hydrogen atom. What is the frequency of the emitted photon?
a) 4.9 X 10^{14} Hz
b) 5.9 X 10^{14} Hz
c) 6.9 X 10^{14} Hz
d) 7.9 X 10^{14} Hz
View Answer
Answer: c
Explanation: The electron makes a transition from n = 5 to n = 2.
$\Delta E=R\left(\frac{1}{n_2^1}-\frac{1}{n_2^2}\right)$
= 45.774 X 10^{-20}J
Frequency, v = ΔE/h
= 6.9 X 10^{14} Hz.

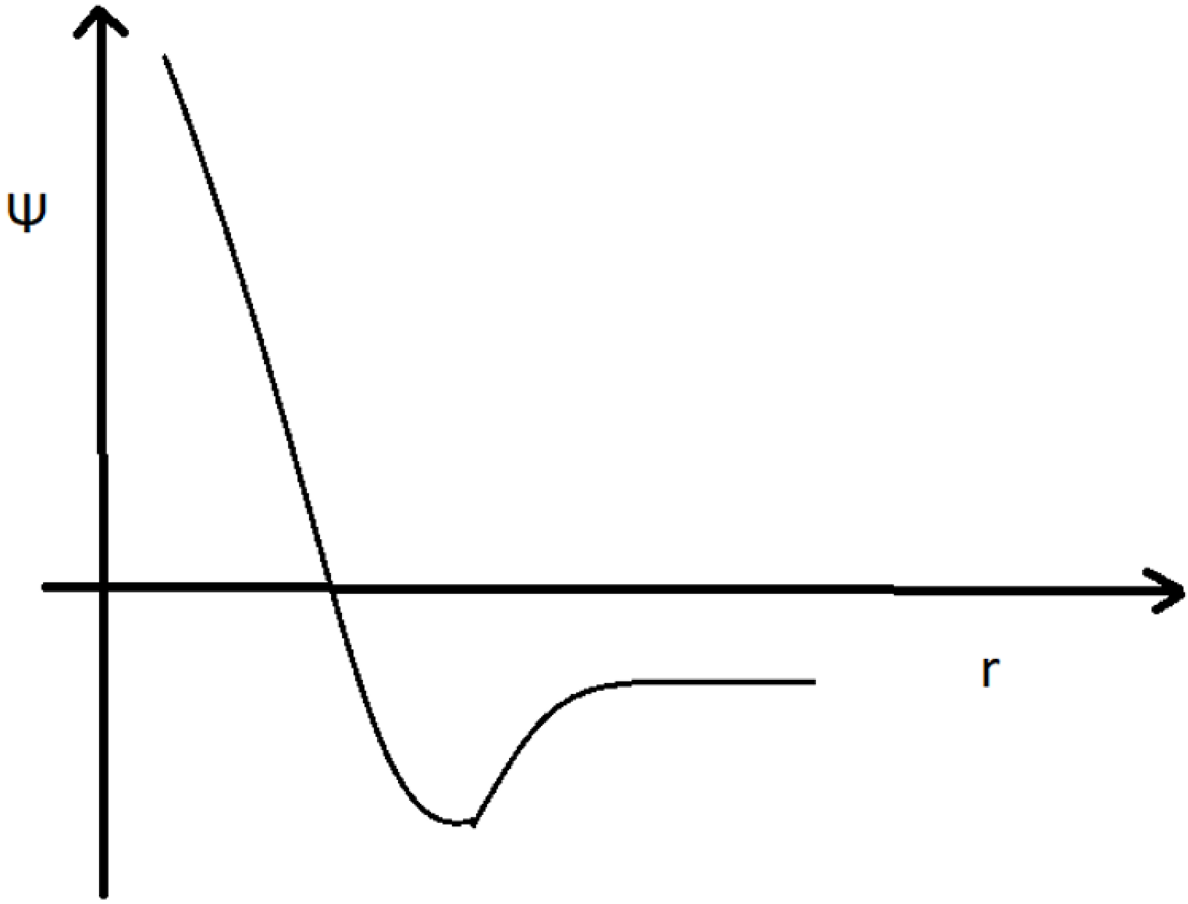
11. What is the azimuthal quantum number for the following sub shell?



a) 1
b) 2
c) 3
d) 4
View Answer
Answer: b
Explanation: The given figure is the subshell $d_{x^2-y^2}$. The azimuthal quantum number for this subshell is 2. It has a total of 5 subshells.

12. The subshell dz^2 has no nodal plane.
a) True
b) False
View Answer
Answer: a
Explanation: The subshell dz^2 has a ring in x-y plane and is based on the z-plane. Thus the probability of finding an electron is never zero for this sub-shell.

13. The following is the wave function for which orbital?



a) 1s
b) 2s
c) 2p
d) 3s
View Answer
Answer: b
Explanation: The given wave function is for the orbital 2s. It shows that after a certain distance from the nucleus, the graph touches the x-axis. Hence, it has a nodal plane.

14. Nodes are the plane where the probability of finding an electron is 1.
a) True
b) False
View Answer
Answer: b
Explanation: Nodal planes are described as the planes where the probability of finding an electron is not equal to zero. The total number of nodes in an orbital is n - 1.

15. The probability of finding an electron is uniform in every direction is in which orbital?
a) s

b) p
c) d
d) p
View Answer
Answer: a
Explanation: For an s-orbital, the probability of finding an electron is uniform in every direction. For p orbitals, the probability of finding an electron is along one direction only.

"Phase and Group Velocity".

1. In a waveguide, which of the following condition is true always?
a) phase velocity = c
b) group velocity = c
c) phase velocity > c
d) phase velocity < c
View Answer
Answer: c
Explanation: The phase velocity is always greater than the speed of light in waveguides. This implies the group velocity is small.

2. The term cos θ is given by 2.5. Find the phase velocity.
a) 3
b) 5
c) 7.5
d) 2.5
View Answer
Answer: c
Explanation: The phase velocity is given by Vp = c cos θ. On substituting for cos θ = 2.5 and the speed of light, we get the phase velocity as 7.5×10^8 m/s.

3. The cut off wavelength and the guided wavelength are given by 0.5 and 2 units respectively. Find the wavelength of the wave.
a) 0.48
b) 0.32
c) 0.45
d) 0.54
View Answer
Answer: a
Explanation: The cut off wavelength and the guided wavelength are related as $(1/\lambda)^2 = (1/\lambda c)^2 + (1/\lambda g)^2$. On substituting for λc = 0.5 and λg = 2, we get λ = 0.48 units.

4. The cut off wavelength of the rectangular waveguide in dominant mode with dimensions 6 cm x 4 cm is
a) 12cm
b) 6cm
c) 4cm
d) 2cm
View Answer
Answer: a
Explanation: The cut off wavelength in the dominant mode is given by $\lambda c = 2a/m$, where a is the broad wall dimension. On substituting for m = 1 and a = 6cm, we get the cut off wavelength as 12cm.

5. The product of the phase and the group velocities is given by the
a) Speed of light
b) Speed of light/2
c) 2 x Speed of light
d) (speed of light)/4
View Answer
Answer: d
Explanation: The product of the phase and the group velocities is given by the square of the speed of the light. Thus Vp x Vg = c^2 is the relation.

6. The phase velocity of a wave having a group velocity of 6 x 10^6 is (in order of 10^8 m/s)
a) 2.4
b) 3
c) 15
d) 150
View Answer
Answer: d
Explanation: We know that the phase and the group velocities are given by Vp x Vg = c^2. On substituting for Vg = 6 x 10^6 and the speed of light, we get Vp = 150 x 10^8 m/s.

7. The group velocity of a wave with a phase velocity of 60 x 10^9 is (in 10^6 order)
a) 1.5
b) 2
c) 2.5
d) 3
View Answer
Answer: a
Explanation: We know that the phase and the group velocities are given by Vp x Vg = c^2. On substituting for Vp = 60 x 10^9 and the speed of light, we get Vg = 1.5 x 10^6 m/s.

8. The phase velocity of a wave having a phase constant of 4 units and a frequency of 2.5×10^9 radian/sec is (in 10^8 order)
a) 3.25
b) 3.75
c) 6.25
d) 6.75
View Answer
Answer: c
Explanation: The phase velocity and the phase constant are related by $V_p = \omega/\beta_g$. On substituting for $\omega = 2.5 \times 10^9$ and $\beta = 4$, we get the phase velocity as 6.25 units.

9. The guided wavelength and the phase constant are related by
a) $2\pi/\beta_g = \lambda_g$
b) $1/\beta_g = \lambda_g$
c) $1/2\pi\beta_g = \lambda_g$
d) $\beta_g = \lambda_g$
View Answer
Answer: a
Explanation: The guided wavelength and the phase constant are related by $2\pi/\beta_g = \lambda_g$, where β_g is the guided phase constant and λ_g is the guided wavelength.

10. The phase velocity refers to a group of waves and the group velocity refers to a single wave. State true/false.
a) True
b) False
View Answer
Answer: b
Explanation: The phase velocity refers to a single wave and the group velocity refers to a group of waves.

11. The phase and group velocities does not depend on which of the following?
a) Frequency
b) Wavelength
c) Phase constant
d) Attenuation constant
View Answer
Answer: d
Explanation: The phase and the group velocities are directly related by the frequency, wavelength and the phase constant. It is independent of the attenuation constant.

12. The distance between two successive points in a waveguide is the
a) Guided wavelength
b) 2 x guided wavelength
c) Guided wavelength/2

d) (guided wavelength)/4

View Answer

Answer: c

Explanation: The distance between two successive points in a waveguide is equal to half of the guided wavelength.

"Waveguide Current and Excitation".

1. The source voltage of a 75ohm transmission line is given by 150V. Find the load current.

a) 0.5
b) 2
c) 4
d) 1

View Answer

Answer: b

Explanation: The load current is given by $I_L = V_S/Z_0$. On substituting for $V_S = 150$ and $Z_0 = 75$, we get $I_L = 150/75 = 2A$.

2. The guided terminations are used to

a) Increase reflection
b) Increase transmission
c) Eliminate reflection loss
d) Eliminate attenuation

View Answer

Answer: c

Explanation: The guided termination refers to the waveguide shorted by conducting plates. This is done in order to eliminate the reflection losses.

3. Which type of wave does the resonant cavity produce?

a) Standing waves
b) Guided waves
c) Transmitted waves
d) Attenuated waves

View Answer

Answer: a

Explanation: Resonant cavity is the waveguide shorted by a conducting plate. This is to reduce the reflection losses. Such arrangement leads to standing waves.

4. Which of the following parameter cannot be calculated from the standing waves?

a) Peak voltage and peak current
b) SWR

c) Reflection and transmission coefficients
d) Attenuation constant
View Answer
View AnswerAnswer: d
Explanation: The peak voltage and current can be directly measured from the standing waves. The standing wave ratio, reflection coefficient and the transmission coefficient can also be calculated from it. Only the attenuation constant cannot be calculated directly.

5. For efficient transmission, the characteristic impedance of the transmission line has to be
a) 50 ohm
b) 75 ohm
c) Either 50 or 75 ohm
d) Neither 50 nor 75 ohm
View Answer
Answer: c
Explanation: Generally, for ideal transmission lines, the characteristic impedance should be either 50 ohm or 75 ohm.

6. The cavity resonators are used in the klystron amplifiers for
a) Amplifying RF signals
b) Amplifying microwave signals
c) Attenuating RF signals
d) Attenuating microwave signals
View Answer
Answer: b
Explanation: The cavity resonators are employed in the klystron amplifiers for amplifying the microwave signals.

7. The cavity resonators used in the reflex klystron oscillators are for
a) Generating RF signals
b) Generating microwave signals
c) Amplifying RF signals
d) Amplifying microwave signals
View Answer
Answer: b
Explanation: Oscillators are devices that generate signal waveforms. The reflex klystron oscillator is used to generate microwave signals.

8. One of the applications of the cavity resonators is duplexer in RADAR systems. State true/false.
a) True

b) False

View Answer

Answer: a

Explanation: Cavity resonator is used in duplexers of RADAR systems, as resonant cavity in transmit receive (TR) tubes and antitransmit receive (ART) tubes.

9. Cavity wave meters are used to measure which parameter of the wave?
a) Wavelength
b) Reflection factor
c) Phase
d) Frequency

View Answer

Answer: d

Explanation: Cavity resonators are used in cavity wave meters for the measurement of frequency of the microwave signals.

10. The waveguides are terminated by the procedure of
a) Trimming
b) Polishing
c) Tapering
d) Pruning

View Answer

Answer: c

Explanation: A waveguide is terminated by concept of tapered or exponential line and uses a dielectric having considerable conductivity to provide power absorbing properties. This will eliminate the reflection losses.

“Schrodinger Equation (Time Dependent Form)”.

1. Which of the following is the correct expression for the Schrödinger wave function?
a) $i\hbar\frac{d\Psi}{dt}=-i\frac{\hbar}{2m}\frac{\partial\Psi}{\partial x}+U\Psi$
b) $i\hbar\frac{d\Psi}{dt}=-i\frac{\hbar}{2m}\frac{\partial^2\Psi}{\partial x^2}+U\Psi$
c) $i\hbar\frac{d\Psi}{dt}=-i\frac{\hbar^2}{2m}\frac{\partial\Psi}{\partial x}+U\Psi$
d) $i\hbar\frac{d\Psi}{dt}=-i\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2}+U\Psi$

View Answer

Answer: d

Explanation: The correct expression for the Schrödinger wave equation is $i\hbar\frac{d\Psi}{dt}=-i\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2}+U\Psi$. Schrodinger equation is a basic principle in itself.

2. For a quantum wave particle, E = _____________
a) $\hbar$ k
b) $\hbar$ ω
c) $\hbar$ ω/2

d) $\hbar$ k/2

View Answer

Answer: b

Explanation: The Energy of a wave particle is given as $\hbar\omega$ while the momentum of the particle is given as $\hbar$ k. These are the desired relation.

3. Schrodinger Wave equation can be derived from Principles of Quantum Mechanics.
a) True
b) False

View Answer

Answer: b

Explanation: Schrodinger equation is a basic principle in itself. It cannot be derived from other principles of physics. Only, it can be verified with other principles.

4. Which of the following can be a wave function?
a) tan x
b) sin x
c) cot x
d) sec x

View Answer

Answer: b

Explanation: Out of all the given options, sin x is the only function, that is continuous and single-valued. All the rest of the functions are either discontinuous or double-valued.

5. Which of the following is not a characteristic of wave function?
a) Continuous
b) Single valued
c) Differentiable
d) Physically Significant

View Answer

Answer: d

Explanation: The wave function has no physical significance. It merely helps in determining the state of a particle. It is the square of the wave function that has a physical significance.

6. Find the function, f(x), for which X f(x) = $-i\hbar a2p_x f(x)$, where a is the real quantity.
a) ke^{-x2}
b) $ke^{-x2/2a}$
c) $ke^{-x2/2a^2}$

d) $ke^{-x^2/2a}$

View Answer

Answer: c

Explanation: Now, given that, X f(x) = $-i\hbar a2p_x f(x)$.

X f(x) = $-i\hbar a2p_x f(x)/dx$

$df/f = -xdx/a^2$

$\ln f = -x^2/2a^2 + C$

$f = ke^{-x^2/2a^2}$.

7. dΨ/dx must be zero.

a) True

b) False

View Answer

Answer: b

Explanation: For a wave function, dΨ/dx, must be continuous and single-valued everywhere, just like Ψ. Also, Ψ must be normalizable.

8. Any wave function can be written as a linear combination of _________________

a) Eigen Vectors

b) Eigen Values

c) Eigen Functions

d) Operators

View Answer

Answer: c

Explanation: A wave function describes the state of a particle. It does not have a physical significance. Moreover, it can be written as a linear combination of Eigen functions, i.e., Ψ(x) = AF(x) + BG(x).

9. The Schrödinger is a differential equation.

a) True

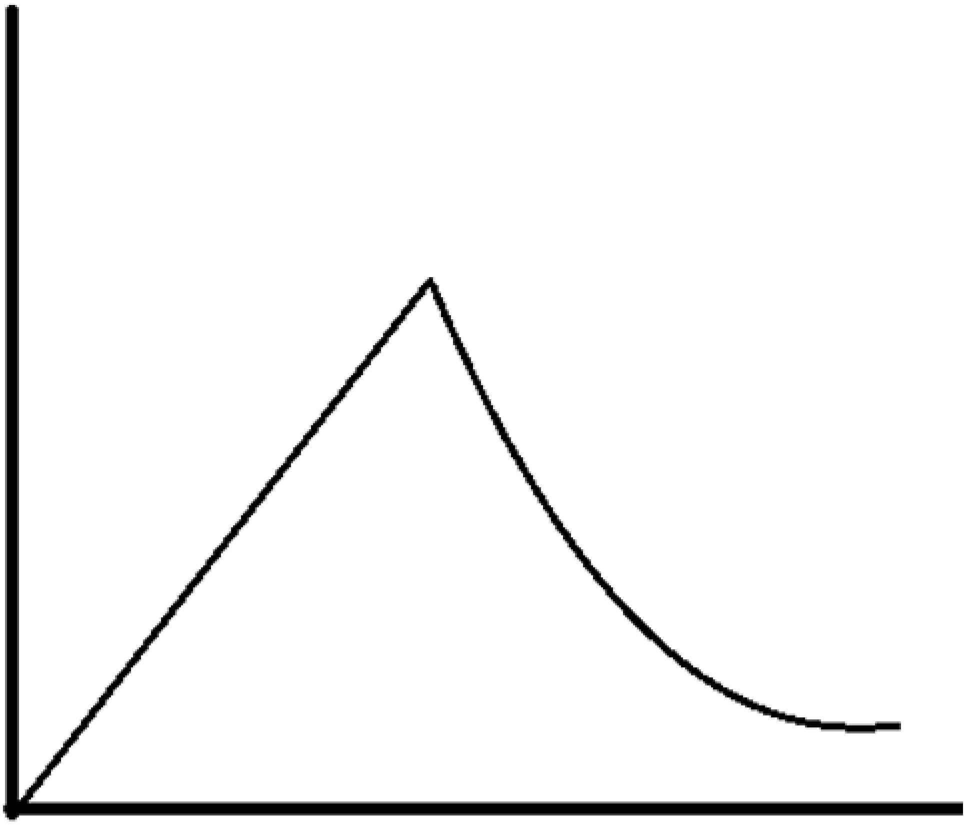
b) False

View Answer

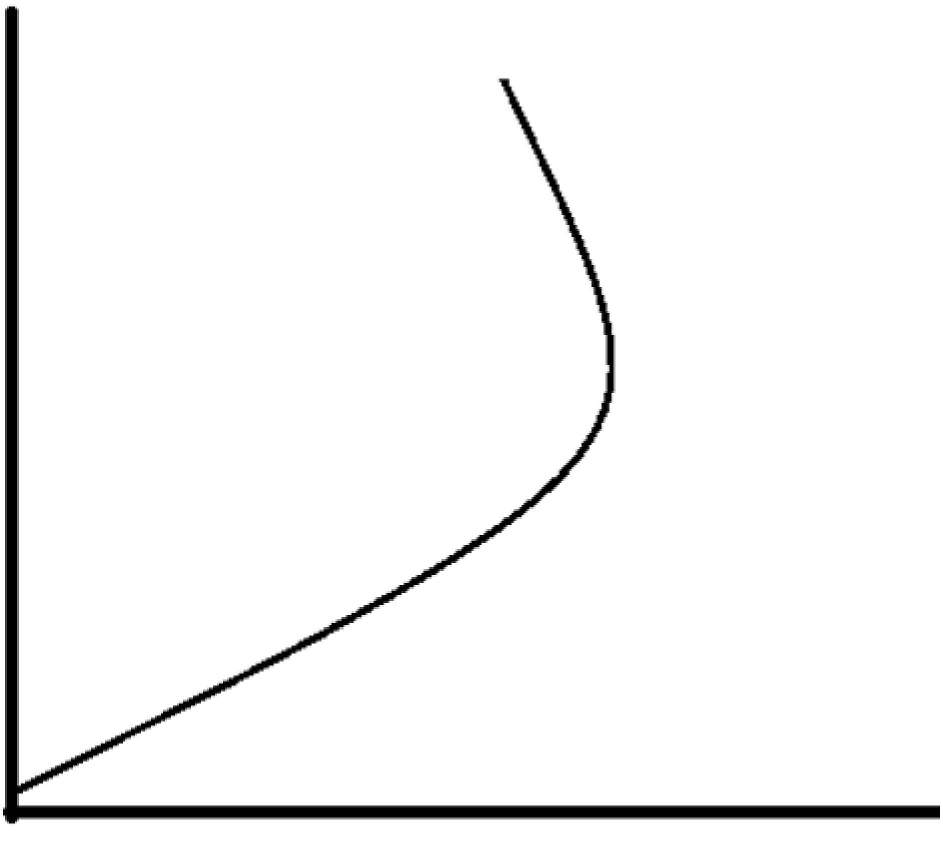
Answer: b

Explanation: The Schrodinger wave equation generated is a partial differential equation. It is a basic principle in itself and cannot be derived from other principles of physics. There are two types of partial differential equation time dependent form and steady-state form.

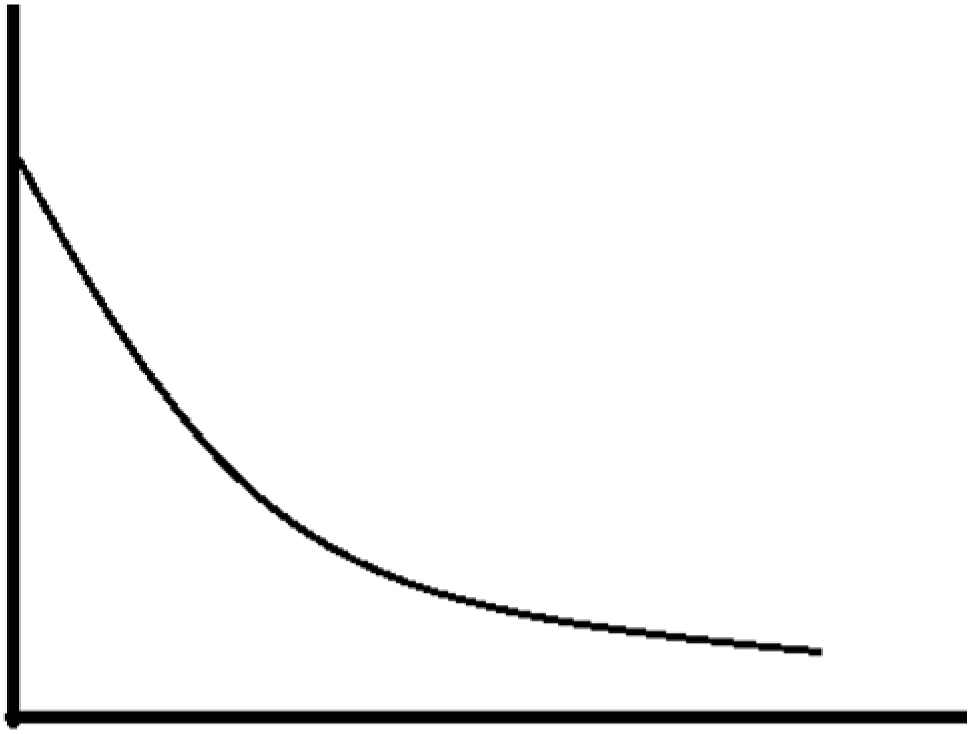
10. Which of the following can be a solution of Schrodinger equation?



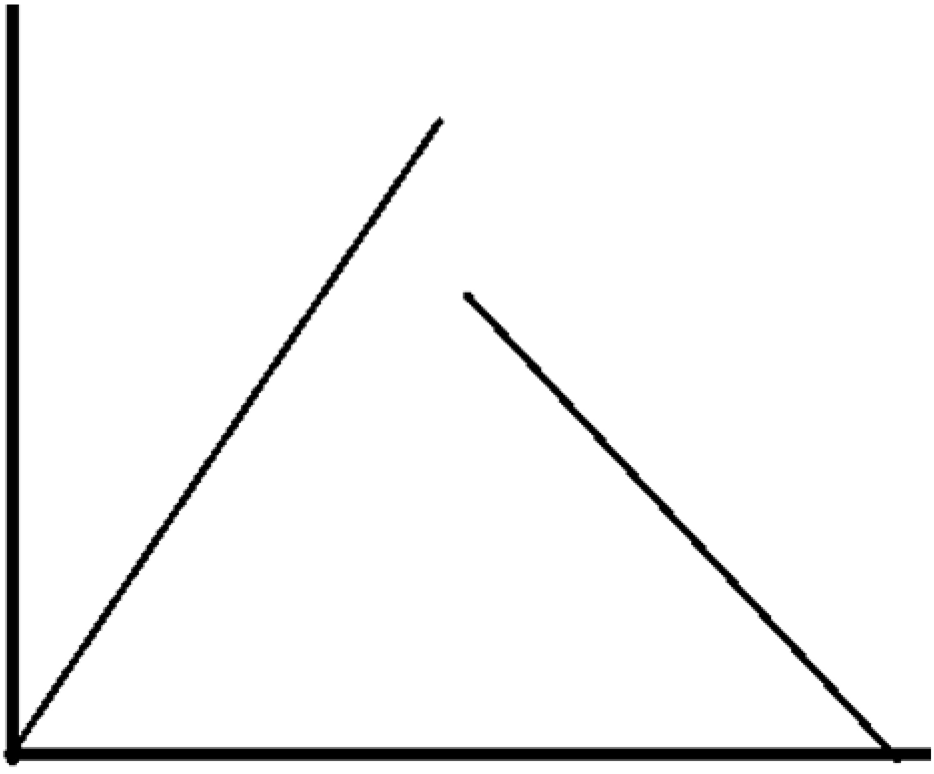
a)



b)



c)

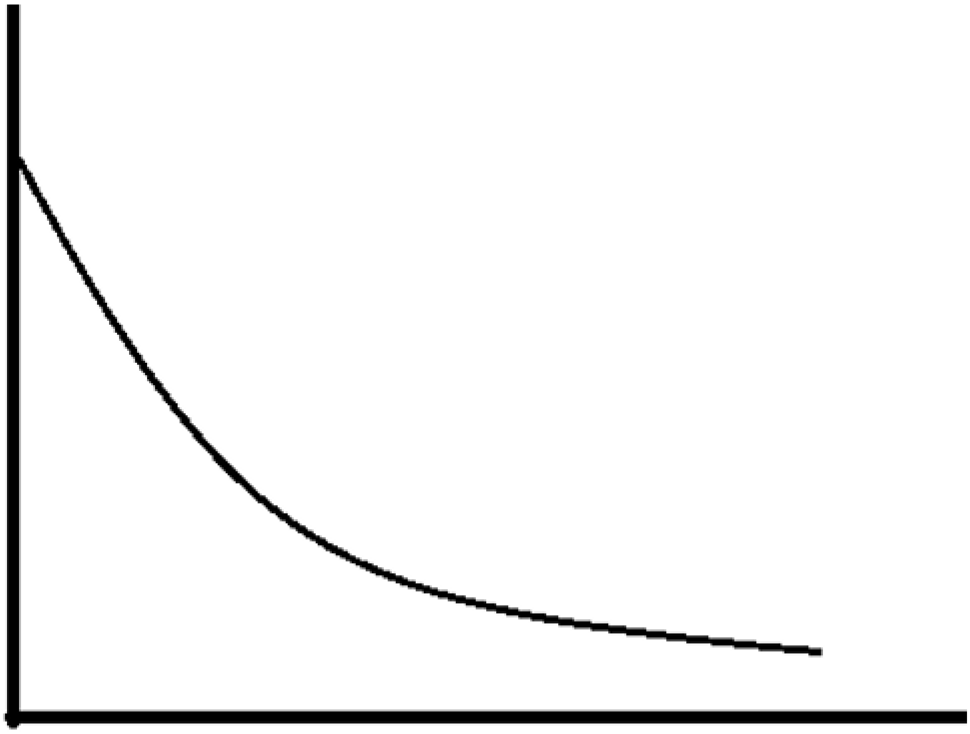


d)

View Answer

Answer: c

Explanation: Out of the following, only the below diagram can be the solution of the Schrodinger Wave equation. because other diagram does not have a continuous dΨ/dx. Some diagrams are double valued and discontinuous also.



“Schrodinger Equation (Steady State Form)”.

1. Which of the following is the correct expression for the steady-state form of Schrödinger wave function?
a) $P\Psi=-i\hbar 2m\partial\Psi\partial x+U\Psi$
b) $E\Psi=-i\hbar 2m\partial^2\Psi\partial x^2+U\Psi$
c) $E\Psi=-i\hbar_z 2m\partial\Psi/\partial x+U\Psi$
d) $E\Psi=-i\hbar_z 2m\partial^2\Psi\partial x^2+U\Psi$
View Answer
Answer: d
Explanation: The correct expression for the Steady state form of the Schrödinger wave equation is $E\Psi=-i\hbar_z 2m\partial^2\Psi\partial x^2+U\Psi$. It is different from the time-dependent for, as it depends on position of the particle only.

2. Which function is considered independent of time to achieve the steady state form?
a) Ψ
b) dΨ/dt
c) $d^2\Psi/dx^2$
d) U
View Answer
Answer: d
Explanation: The potential energy of a particle is considered to not depend on time explicitly, the forces that act on it, and hence U, vary with the position only.

3. For 3-D system, the Schrödinger equation changes.
a) True
b) False
View Answer
Answer: b
Explanation: Schrodinger equation is a basic principle. When considered for a 3-D system, only the new dimensions, in which the equation was considered, are added.

4. The Steady-state form of Schrodinger wave equation is ____________
a) Linear
b) Quadratic
c) Differential equation
d) Derivable
View Answer
Answer: a
Explanation: The Steady-state Schrodinger Wave equation is a linear in the wave function Ψ. It means, that no term has \Psi with a degree greater than 1.

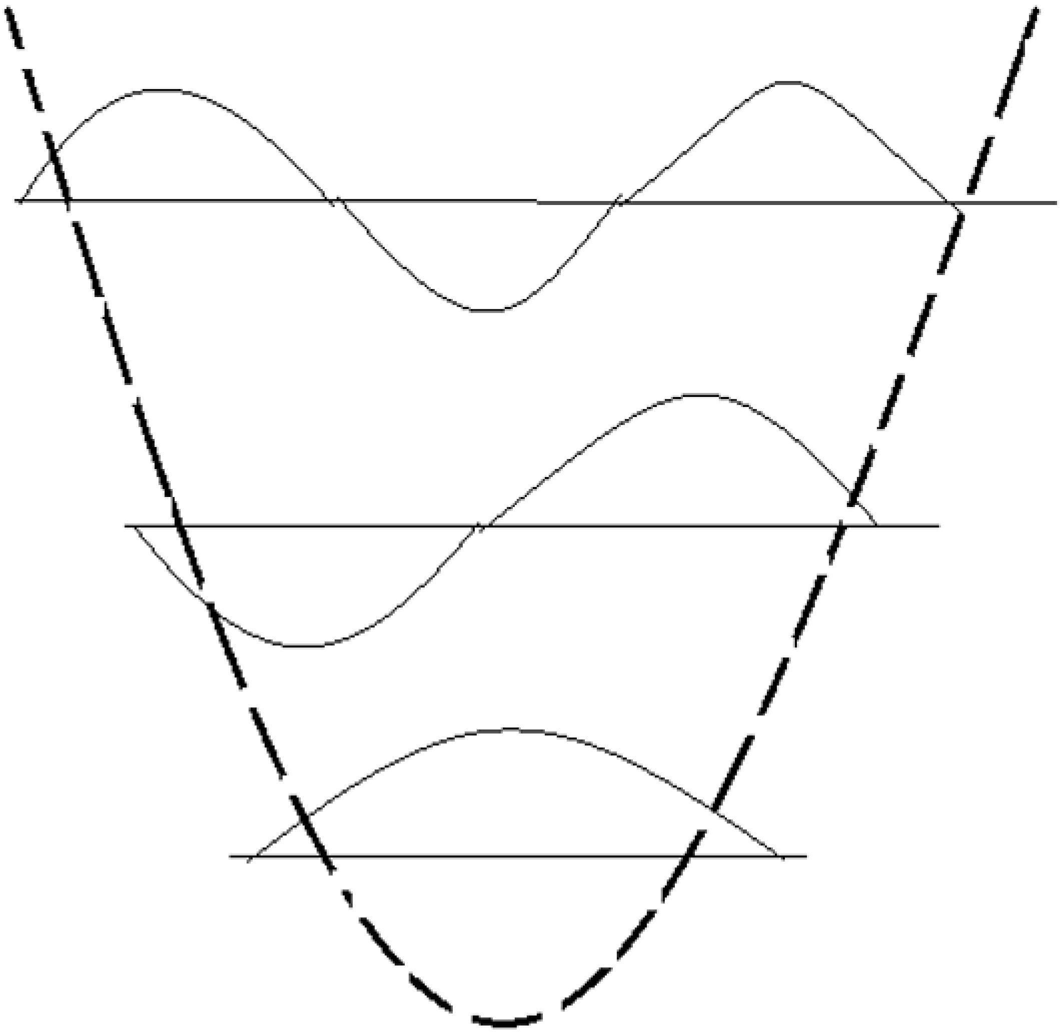
5. The values of Energy for which Schrodinger's steady state equation can be solved is called as ____________
a) Eigen Vectors
b) Eigen Values
c) Eigen Functions
d) Operators
View Answer
Answer: b
Explanation: Eigen values are the value of Energy for which Schrodinger's steady state equation can be solved. The corresponding wave function is called Eigen Function.

6. The Energy levels are proportional to _____________
a) n
b) n^{-1}
c) n^2
d) n^{-2}
View Answer
Answer: d
Explanation: The energy levels for which the Schrodinger's steady state equation can be solved is inversely proportional to the square of quantum number.

7. Total Energy is quantized but not angular momentum of the quantum particle.
a) True
b) False
View Answer
Answer: b
Explanation: Both the Total energy and the angular momentum of the quantum particle is quantized. In case of Hydrogen atoms, L = $l(l+1)\hbar$−−−−−−−√, where l = 0, 1, 2, …. (n-1).

8. Which quantity is said to be degenerate when $H\Psi_n = E_n\Psi_n$?
a) Eigen Vectors
b) Eigen Values
c) Eigen Functions
d) Operators
View Answer
9. For a box with infinitely hard walls, the potential is maximum at ____________
a) L
b) 2L
c) L/2
d) 3L
View Answer
Answer: a
Explanation: In a box with infinitely high barriers with infinitely hard walls, the potential is infinite when x = 0 and when x = L.

10. Which device is shown in the following figure?



a) Particle in a Box
b) Harmonic Oscillator
c) SHM
d) Atomic spectroscope
View Answer
Answer: b
Explanation: The following figure shows a Harmonic oscillator. The energy levels in this device are quantize and the lowest energy is not equal to zero.

Tunnel Effect".

1. The transmission based on tunnel effect is that of a plane wave through a

____
a) Circular Barrier
b) Opaque Object
c) Rectangular Barrier
d) Infinitely small barrier
View Answer

Answer: c
Explanation: The transmission of a plane wave through a rectangular barrier is dependent on the tunnel effect. It is also called Rectangular potential barrier.

2. he particle has a finite, non-zero, potential for the region ____________
a) $x > 0$
b) $x < 0$
c) $0 < X < a$
d) $x > a$
View Answer
Answer: c
Explanation: The particle incident on the rectangular barrier has a finite and non-zero potential, when the particles lies between 0 and a.

3. In quantum mechanics, if the energy of the particle, E, is less than the energy required to enter a region, U, the particle is always reflected back.
a) True
b) False
View Answer
Answer: b
Explanation: In Quantum Mechanics, even if $E < U$, there is a chance that the particle might tunnel through it. This concept is different from the classical mechanics.

4. Tunnel effect is notably observed in the case of ____________
a) X-rays
b) Gamma rays
c) Alpha Particles
d) Beta Particles
View Answer
Answer: c
Explanation: The tunnel effect actually occurs, notably in the case of alpha particles emitted by certain radioactive nuclei. It has the energy of a few MeV.

5. The solution of Schrodinger wave equation for Tunnel effect is of the form

____

a) $Ae^{ikx} + Be^{ikx}$
b) $Ae^{ikx} - Be^{ikx}$
c) $Ae^{ikx} + Be^{-ikx}$
d) $Ae^{ikx} - Be^{-ikx}$
View Answer
Answer: c
Explanation: When the Schrodinger Wave equation is solved for the particle

undergoing tunnel effect, the general solution of wave function is of the form: Ae^{ikx}+ Be^{-ikx}.

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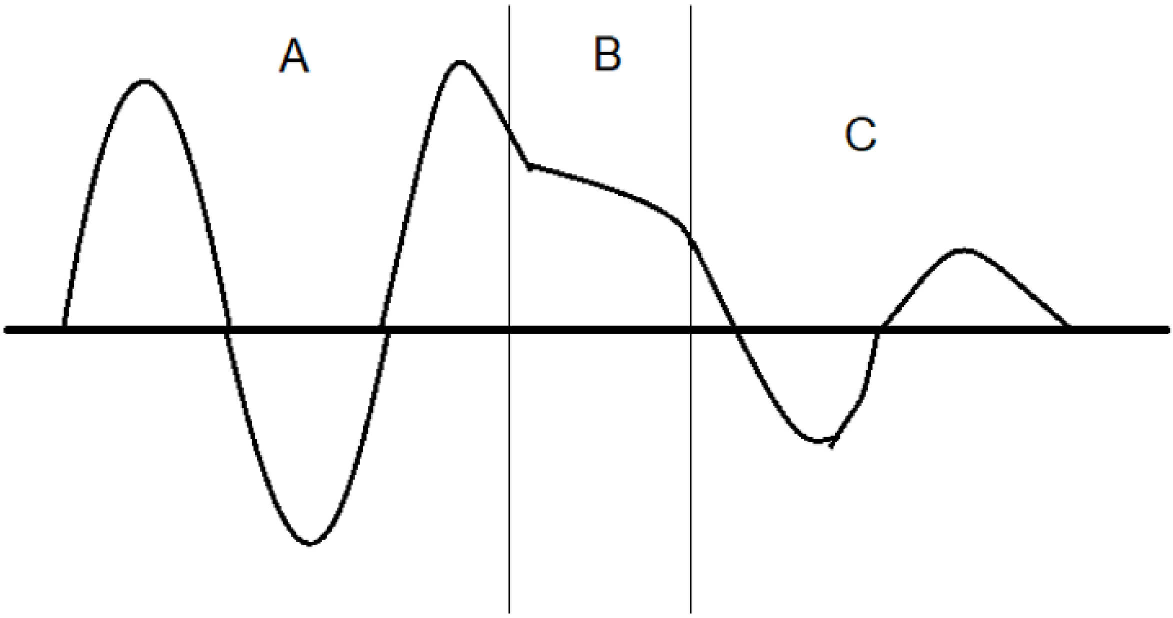
6. The particle with wave function Ae^{kx}+ Be^{-kx} represents ___________
a) Oscillating particle
b) Moving Particle
c) Probable Particle
d) No such wave function
View Answer
Answer: c
Explanation: The given wave function does not oscillate and does not represent a moving particle. Its probability density is not zero, so there is a finite probability of finding a particle within the barrier.

7. Tunnel effect happens during nuclear fusion in stars.
a) True
b) False
View Answer
Answer: a
Explanation: Tunnel effect plays an essential role in several physical phenomena, such as the nuclear fusion that occurs in main sequence stars like the Sun, tunnel diode, quantum computing, and in the scanning tunneling microscope.

8. Tunnel effect can be explained on the basis of ___________
a) Schrodinger's Equation
b) Particle in a Box
c) Heisenberg's uncertainty principle
d) De-Broglie Wavelength
View Answer
Answer: c
Explanation: The tunnel effect can be understood in terms of the uncertainty principle. Using it, we can say that the particle must be able to enter the barrier, and once inside it, has the possibility of continuing on.

9. The expression for Transmission probability is ___________
a) e^{-kL}
b) e^{-2kL}
c) e^{kL}
d) e^{2kL}
View Answer
Answer: b
Explanation: The transmission probability of a particle can be expressed as: e^{-2kL}. It shows that the larger is L, smaller is the transmission probability.

10. In which of the following regions is E<V?



a) A
b) B
c) C
d) None of the regions
View Answer
Answer: b
Explanation: In the given figure, the region B is the one where the energy of the particle, E, is less than the potential energy of the barrier. This is where the tunnel effect is observed.

"Fermi-Dirac Distribution".

1. Fermi-Dirac statistics is for the ________
a) Distinguishable particles
b) Symmetrical Particles
c) Particles with half integral spin
d) Particles with integral spin
View Answer
Answer: c
Explanation: The Maxwell-Boltzmann statistics is for the distinguishable particles, which are basically the classical particles like atoms and molecules.

2. The difference between fermions and bosons is that bosons do not obey ______
a) Aufbau principle
b) Pauli's Exclusion Principle
c) Hund's Rule of Maximum Multiplicity
d) Heisenberg's Uncertainty Principle
View Answer

Answer: b
Explanation: The particles that follow Pauli's Exclusion Principle are defined as Fermions while that don't are called bosons. Bosons have an integral spin number.

3. The Maxwell-Boltzmann law is given by the expression n_i = ________
a) $ge^{\alpha+\beta E}$
b) $ge^{\alpha+\beta E}-1$
c) $ge^{\alpha+\beta E}+1$
d) $ge^{\alpha+\beta E}+k$
View Answer
Answer: c
Explanation: The correct expression for the Maxwell-Boltzmann law is n_i = $ge^{\alpha+\beta E}+1$, where α depends on the volume and the temperature of the gas and β is equal to 1/kT.

4. The wave function of fermions is not _________
a) Continuous
b) Single Valued
c) Symmetric
d) Differentiable
View Answer
Answer: c
Explanation: The particles which have antisymmetric wave function having half odd integral spin number and obey Pauli's principle are called fermions.

5. Fermi-Dirac statistics cannot be applied to ________
a) Electrons
b) Photons
c) Fermions
d) Protons
View Answer
Answer: b
Explanation: Fermi-Dirac Statistics can be applied to particles having half odd integral spin number and obey Pauli's principle which are electrons, fermions and protons. Photon has an integral spin number.

6. The distribution function is given by ________
a) $1Ae^{EnT}+1$
b) $1Ae^{EnT}-1$
c) $1e^{EnT}+A$
d) $1e^{EnT}-A$
View Answer

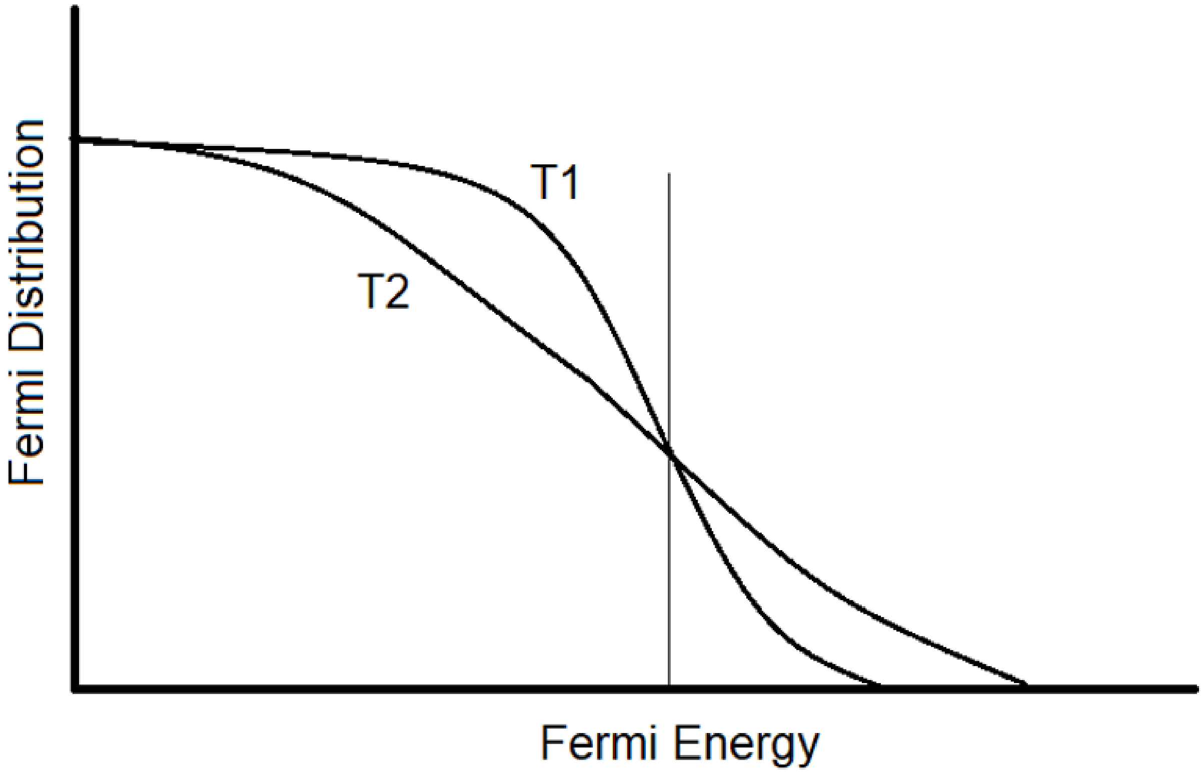
Answer: a
Explanation: The distribution function is given by $\frac{1}{Ae^{\frac{E}{nT}}+1}$, where A = $e^{-\frac{E_F}{nT}}$ The energy E_F is called the Fermi energy and is constant for a given system.

7. At T > 0K, the probability of a state with E > E_F filled is zero.
a) True
b) False
View Answer
Answer: b
Explanation: At T > 0 K, the probability that a state with E > E_F is filled is ½. Hence, fermi energy is the energy at which the probability of occupation is ½ at any temperature above 0 K.

8. The expression for mean energy is given by ________
a) $\frac{3}{5}NE_F$
b) $\frac{2}{5}NE_F$
c) $\frac{3}{5}E_F$
d) $\frac{2}{5}E_F$
View Answer
Answer: a
Explanation: The expression for the mean energy of an electron at absolute zero is given by $\frac{3}{5}NE_F$. The expression $\frac{3}{5}E_F$ is called the zero point energy.

9. For all the quantum states with energy greater than Fermi energy to be empty in a Fermi-Dirac system, the temperature should be ______
a) 273 K
b) 373 K
c) 0 K
d) 100 K
View Answer
Answer: c
Explanation: We know that the Fermi-Dirac distribution is given by:
$F_{FD}(E)$ = $\frac{1}{e^{\frac{E-E_F}{nT}}+1}$
For all the quantum states with energy greater than Fermi energy to be empty,
$F_{FD}(E)$ = 0, for E > E_F and $F_{FD}(E)$ = 1, for E < E_F
Therefore, for E < E_F $\frac{1}{e^{\frac{E-E_F}{nT}}+1}=1$
$e^{\frac{E-E_F}{nT}}=0$
As, E < E_F, E- E_F < 0. Therefore, to satisfy the given statement,
T = 0 K
Thus, we can define Fermi energy as the energy of the uppermost occupied level at 0 K.

10. What is the relationship between T1 and T2?



a) T1 > T2
b) T1 < T2
c) T1 = T2
d) Insufficient Information
View Answer
Answer: b
Explanation: The given figure shows the variation of Fermi-Dirac distribution with energy E. In this case, T2 > T1, according to the expression: $F_{FD}(E) = \frac{1}{e^{\frac{E-E_F}{nT}}+1}$.

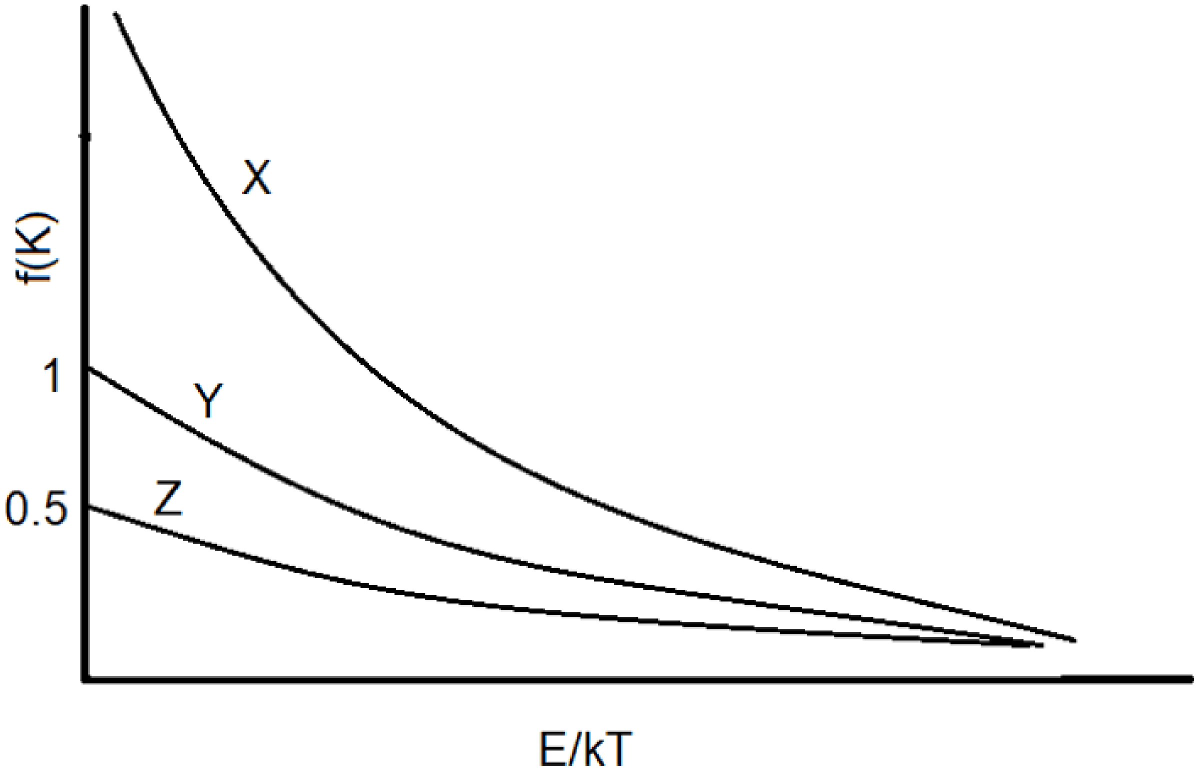
11. The density of silver is 10.5 g/cm^3 and its atomic weight is 108. If each atom contributes one electron for conduction, what is the fermi energy?
a) 2.12 eV
b) 3.31 eV
c) 4.69 eV
d) 5.51 eV
View Answer
Answer: d
Explanation: Fermi Energy, $E_F = \frac{h^2}{8m}\left(\frac{3N}{\pi v}\right)^{2/3}$
Here, N /V = 10.5 X 6.02 X 10^{23}/108
= 5.85 X 10^{28} m^{-3}
Therefore, $E_F = \frac{6.626 X 6.626}{8 X 9.1 \times 10^{-19}} \times \left(\frac{3 \times 5.585}{\pi}\right)^{2/3}$
= 8.816 X 10^{-19}J
= 5.51 eV.

12. The Fermi energy of a material is 3.45 eV. What is the zero-point energy of the material?
a) 1.02 eV
b) 2.07 eV
c) 3.45 eV
d) 4.16 eV
View Answer
Answer: b
Explanation: As we know, the fermi energy of the material is 3.45 eV.
Now, zero-point energy =$35E_F$
= 3/5 X 3.45 eV
= 2.07 eV.

13. The average energy of one electron silver is 3.306 eV. What is the fermi-energy of Silver at 0 K?
a) 2.32 eV
b) 3.78 eV
c) 4.12 eV
d) 5.51 eV
View Answer
Answer: d
Explanation: We know, Average Energy, E =$35NE_F$
Here, E = 3.306 eV, N = 1
Therefore, we get: E_F = 5E/3
= 5.51 eV.

14. In Fermi-Dirac Statistics, one energy state can be occupied by more than one particle.
a) True
b) False
View Answer

15. Which of the following is the curve for Fermi-Dirac statistics?



a) X
b) Y
c) Z
d) None
View Answer
Answer: c
Explanation: As seen the curve the order of the ration of f(K) with E/kT is in the order X > Y > Z. Here, Y is Maxwell-Boltzmann Statistics, X is Bose-Einstein Statistics and Z is Fermi-Dirac Statistics.