



PHYSICS

BOOKS - NCERT PHYSICS (ENGLISH)

DUAL NATURE OF RADIATION AND MATTER

Multiple Choice Questions Mcqs

1. A particle is dropped from a height H . The de-broglie wavelength of the particle as a function of height is proportional to

A. H

B. $H^{1/2}$

C. H^0

D. $H^{-1/2}$

Answer:



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2. The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with 1MeV energy is nearly

A. 1.2 nm

B. 1.2×10^{-3} nm

C. 1.2×10^{-6} nm

D. 1.2×10 nm

Answer:



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3. Consider a beam of electrons (each electron with energy E_0) incident on a metal surface kept in an evacuated chamber. Then

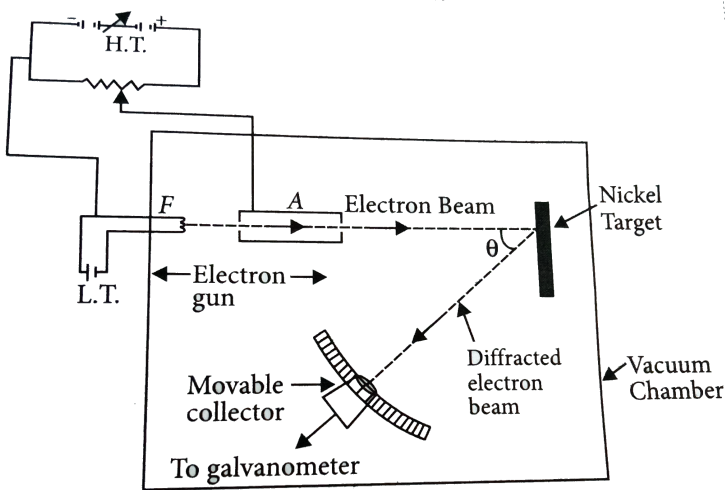
- A. no electrons will be emitted only photons
can emit electrons
- B. electrons can be emitted but all with an
energy, E_o
- C. electrons can be emitted with any energy,
with a maximum of $E_o - \phi$ (ϕ is the work
function)
- D. electrons can be emitted with any energy,
with a maximum of E_o

Answer:



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4. Consider figure. Suppose the voltage applied to A is increased. The diffracted beam will have the maximum at a value of θ that



A. will be larger than the earlier value

B. will be the same as the earlier value

C. will be less than the earlier value

D. will depend on the target

Answer:



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5. A proton, a neutron, an electron and an α -particle have same energy. Then their de-Broglie wavelengths compare as

A. $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$

B. $\lambda_\alpha < \lambda_p = \lambda_n > \lambda_e$

C. $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$

D. $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

Answer:



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6. An electron is moving with an initial velocity

$\vec{v} = v_0 \hat{i}$ and is in a magnetic field $\vec{B} = B_0 \hat{j}$.

Then it's de-Broglie wavelength

A. remains constant

B. increases with time

C. decreases with time

D. increases and decreases periodically

Answer:



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7. An electron (mass m) with an initial velocity

$v = v_0 \hat{i}$ ($v_0 > 0$) is in an electric field

$E = -E_0 \hat{i}$ ($E_0 = \text{constant} > 0$). Its de-Broglie

wavelength at time t is given by

A.
$$\frac{\lambda_0}{\left(1 + \frac{eE_0 t}{m v_0}\right)}$$

B. $\lambda_0 \left(1 + \frac{eE_0t}{mv_0} \right)$

C. λ_0

D. $\lambda_0 t$

Answer:



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8. An electron (mass m) with an initial velocity $\vec{v} = v_0 \hat{i}$ is in an electric field $\vec{E} = E_0 \hat{j}$. If $\lambda_0 = h / mv_0$. It's de-broglie wavelength at time t is given by

A. λ_0

B. $\lambda_0 \sqrt{1 + \frac{e^2 E_0^2 t^2}{m^2 v_0^2}}$

C. $\frac{\lambda_0}{\sqrt{1 + \frac{e^2 E_0^2 t^2}{m^2 v_0^2}}}$

D. $\frac{\lambda_0}{1 + \frac{e^2 E_0^2 t^2}{m^2 v_0^2}}$

Answer:



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9. Relativistic corrections become necessary when the expression for the kinetic energy $\frac{1}{2}mv^2$,

becomes comparable with mc^2 , where m is the mass of the particle. At what de-broglie wavelength will relativistic corrections become important for an electron?

A. $\lambda = 10nm$

B. $\lambda = 10^{-1}nm$

C. $\lambda = 10^{-4}nm$

D. $\lambda = 10^{-6}nm$

Answer:



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10. Two particles A_1 and A_2 of masses $m_1, m_2 (m_1 > m_2)$ have the same de-broglie wavelength. Then

A. their momenta are the same

B. their energies are the same

C. energy of A_1 is less than the energy of A_2

D. energy of A_1 is more than the energy of A_2

Answer:



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11. The de-broglie wavelength of a photon is twice the de-broglie wavelength of an electron. The speed of the electron is $v_e = \frac{c}{100}$. Then

A. $\frac{E_e}{E_p} = 10^{-4}$

B. $\frac{E_e}{E_p} = 10^{-2}$

C. $\frac{p_e}{m_e c} = 10^{-2}$

D. $\frac{p_e}{m_e c} = 10^{-4}$

Answer:



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12. Photons absorbed in matter are converted to heat. A source emitting n photons/ sec of frequency ν is used to convert 1kg of ice at $0^\circ C$ to water at $0^\circ C$. Then, the time T taken for the conversion

A. decreases with increasing n , with ν fixed

B. decreases with n fixed, ν increasing

C. remains constant with n and ν changing

such that $n\nu = \text{constant}$

D. increases when the product $n\nu$ increases

Answer:



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13. A particle moves in a closed orbit around the origin, due to a force which is directed towards the origin. The de-broglie wavelength of the particles varies cyclically between two values λ_1, λ_2 with $\lambda_1 > \lambda_2$. Which of the following statements are true?

A. The particle could be moving in a circular orbit with origin as centre

B. The particle could be moving in an elliptic orbit with origin as its focus

C. When the de-Broglie wavelength is λ_1 , the particle is nearer the origin than when its value is λ_2

D. When the de-Broglie wavelength is λ_2 , the particle is nearer the origin than when its value is λ_1

Answer:



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Very Short Answer Type Questions

1. A proton and an α -particle are accelerated, using the same potential difference. How are the de-Broglie wavelengths λ_p and λ_a related to each other?



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2. (i) In the explanations of photoelectric effect, we assume one photon of frequency ν collides with an electron and transfer its energy. This leads to the equation for the maximum energy E_{\max} of

the emitted electron as $E_{\text{max}} = h\nu - \phi_0$ Where ϕ_0 is the work function of the metal. if an electron absorbs 2 photons (each of frequency ν) what will be the maximum energy for the emitted electron?

(ii) Why is this fact (two photon absorption) not taken into consideration in our discussion of the stopping potential?



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3. There are materials which absorb photon of shorter wavelength and emit photons of longer wavelength. Can there be stable substances which

absorb photons of larger wavelength and emit light of shorter wavelength.



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4. Do all the electrons that absorb a photon come out as photoelectrons?



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5. There are two sources of light, each emitting with a power of $100W$. One emits X-rays of wavelength $1nm$ and the other visible light at

500nm . Find the ratio of number of photons of X-rays to the photons of visible light of the given wavelength?

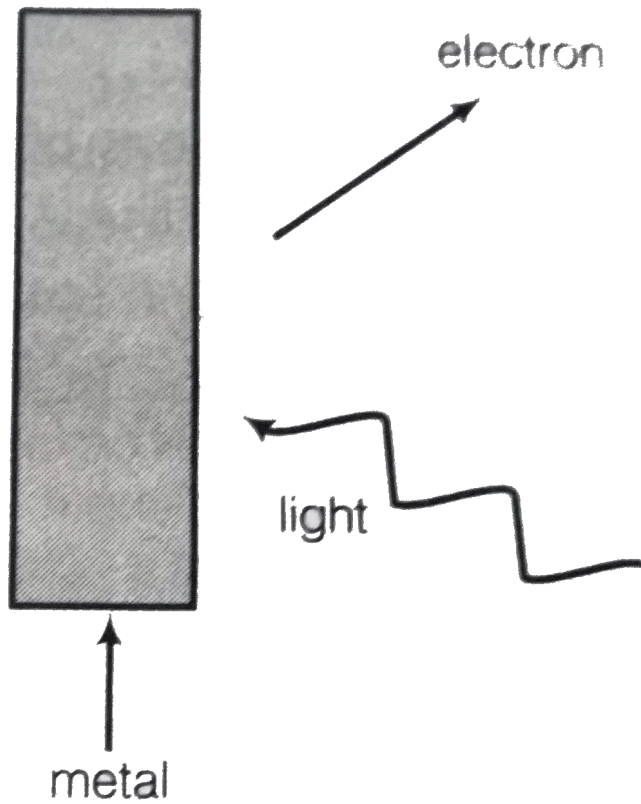


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Short Answer Type Questions

1. Consider figure for photoemission. How would you reconcile with momentum-conservation? Note light (photons) have momentum in a different

direction than the emitted electrons.



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2. Consider a metal exposed to light of wavelength 600nm. The maximum energy of the electrons doubles when light of wavelength 400nm is used. Find the work function in eV.



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3. Assuming an electron is confined to a 1nm wide region, find the wavelength in momentum using Heisenberg Uncertainty principal ($\Delta x \Delta p \approx h$). You can assume the uncertainty in position Δx

and 1nm . Assuming $p \cong \Delta p$, find the energy of the electron in electron volts.



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4. Two monochromatic beam A and B of equal intensity I , hit a screen. The number of photons hitting the screen by beam A is twice that by beam B. Then what inference can you make about their frequencies?



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5. Two particles A and B of de-broglie wavelength λ_1 and λ_2 combine to form a particle C. The process conserves momentum. Find the de-Broglie wavelength of the particle C. (The motion is one dimensional).



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6. A neutron beam of energy E scatters from atoms on a surface with a spacing $d=0.1\text{nm}$. The first maximum of intensity in the reflected beam

occurs at $\theta = 30^\circ$. What is the kinetic energy of E of the beam in eV?



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Long Answer Type Question

1. Consider a thin target (10^{-2} m square, 10^{-3} m thickness) of sodium, which produces a photocurrent of $100 \mu A$ when a light of intensity 100 W/m^2 ($\lambda = 660 \text{ nm}$) falls on it. Find the probability that a photoelectron is produced

when a photon strikes a sodium atom.

[Taken density of Na = 0.97 kg/m^3]



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2. Consider an electron in front of metallic surface at a distance d (treated as an infinite plane surface). Assume the force of attraction by the plate is given as $\frac{1}{4} \frac{q^2}{4\pi \epsilon_0 d^2}$.

Calculate work in taking the charge to an infinite distance from the plate. Taking $d=0.1\text{nm}$, find the work done in electron volts. [Such a force law is not valid for $d \ll 0.1\text{nm}$].



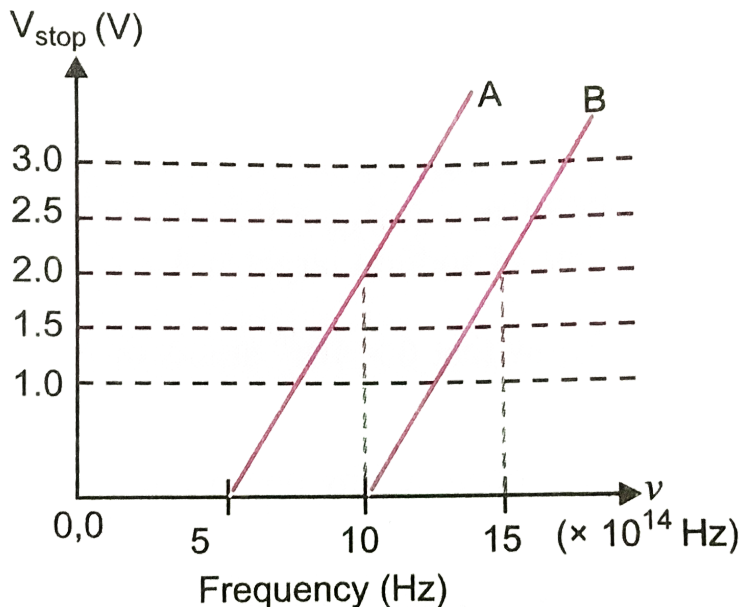
3. A student performs an experiment on photoelectric effect, using two materials A and B.

A plot of $V_{s\top}$ vs ν is given in fig.

(i) Which material A or B has a higher work function?

(ii) Given the electric charge of an electron $= 1.6 \times 10^{-19} C$, find the value of h obtained from the experiment for both A and B. Comment

on whether it is consistent with Einstein's theory.



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4. A particle A with a mass m_A is moving with a velocity v and hits a particle B (mass m_B) at rest (one dimensional motion). Find the change in the

de-Broglie wavelength of the particle A. Treat the collision as elastic.



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5. Consider a $20W$ bulb emitting light of wavelength 5000\AA and shining on a metal surface kept at a distance $2m$. Assume that the metal surface has work function of $2eV$ and that each atom on the metal surface can be treated as a circular disk of radius 1.5\AA .

(i) Estimate no. of photons emitted by the bulb per second. [Assume no other losses] (ii) Will

there be photoelectric emission? (iii) How much time would be required by the atomic disk to receive energy equal to work function $2eV$? (iv) How many photons would atomic disk receive within time duration calculated in (iii) above? (v) Can you explain how photoelectric effect was observed instantaneously? [Hint : Time calculated in part (iii) is from classical consideration and you may further take the target of surface area say $1cm^2$ and estimate what would happen?]



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