PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

DUAL NATURE OF RADIATION AND MATTER

Jee Main 5 Year At A Glance

1. If the de Broglie wavelengths associated with a proton and α particle are equal then the ration of velocites of the proton and the α paricle will be :

A. $1:4$

B. $1:2$

C. $4:1$

D. $2:1$

Answer: C

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2. Two electrons are moving with non-relativistic speeds perpendicular to each other. If corresponding de Broglie wavelengths are λ_1 and λ_2 , their de Broglie wavelength in the frame of reference attached to their centre of mass is:

A. $\lambda_{CM} = \lambda_1 = \lambda_2$

B. $\frac{1}{\lambda_1} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

C. $\lambda_{CM} = \frac{2\lambda_1\lambda_2}{\sqrt{\lambda_1^2 + \lambda_2^2}}$

D. $\lambda_{CM} = \left(\frac{\lambda_1 + \lambda_2}{2}\right)$

Answer: C

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3. Both the nucleus and the atom of some element are in their respective first excited states. They get de-excited by emitting photons of wavelengths λ_N, λ_A respectively. The ratio $\frac{\lambda_N}{\lambda_A}$ is closest to :

A. 10^{-6}

B. 10

C. 10^{-1}

D. 10^{-10}

Answer: A

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4. A laser light of wavelength 660 nm is used to weld Retina detachment. If a laser pulse of width 60 ms and power 0.5 kW is used, the approximate number of photons in the pulse are (Take Planck's Constant, $h = 6.62 \times 10^{-34} Js$)

A. 10^{20}

B. 10^{18}

C. 10^{22}

D. 10^{19}

Answer: A

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5. A particle A of mass m and initial velocity v collides with a particle of mass $m/2$ which is at rest. The collision is head on, and elastic. The ratio of the de-broglie wavelength λ_A and λ_B after the collision is

A. $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$

B. $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$

C. $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$

D. $\frac{\lambda_A}{\lambda_B} = 2$

Answer: D

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6. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\frac{\lambda}{2}$. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times than in the first case , the work function of the surface of the material is

(h = Plank's constant , c = speed of light)

A. $\frac{hc}{2\lambda}$

B. $\frac{hc}{\lambda}$

C. $\frac{hc}{3\lambda}$

D. $\frac{3hc}{\lambda}$

Answer: A

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7. In a photoelectric experiment, with light of wavelength λ, the fastest election has speed v. If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will become

A. $= v\left(\frac{4}{3}\right)^{\frac{1}{2}}$

B. $= v\left(\frac{3}{4}\right)^{\frac{1}{2}}$

C. $> v\left(\frac{4}{3}\right)^{\frac{1}{2}}$

D. $< v\left(\frac{4}{3}\right)^{\frac{1}{2}}$

Answer: C

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8. De - Broglie wavelength of an electron accelerated by a voltage of 50 V is close to

$\left(|e| = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31}\right)$

A. 2.4Å

B. 0.5Å

C. 1.7Å

D. 1.2Å

Answer: C

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9. A photon of wavelength λ is scattered from an electron, which was at rest. The wavelength shift $\Delta\lambda$ is three times of λ and the angle of scattering θ is 60° . The angle at which the electron recoiled is ϕ . The value of tan ϕ is: (electron speed is much smaller than the speed of light)

A. 0.16

B. 0.22

C. 0.25

D. 0.28

Answer: B

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10. For which of the following particles will it be most difficult to experimentally verify the de Broglie relationship ?

A. an electron

B. a proton

C. an α-particle

D. a dust particle

Answer: D

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Exercise 1 Concept Builder

1. A particle with rest mass m_0 is moving with velocity c. what is the de-Broglie wavelength associated with it?

A. ∞

B. 0

C. $m_0 c / h$

D. $hv / m_0 c$

Answer: B

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2. If a proton and electron have the same de Broglie wavelength, then

A. both have same kinetic energy

B. proton has more K.E. than electron

C. electron has more K.E. than proton

D. both have same velocity

Answer: C

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3. Cathode rays and canal rays produced in a certain discharge tube are deflected in the same direction if

A. a magnetic field is applied normally

B. an electric field is applied normally

C. an electric field is applied tangentially

D. a magnetic field is applied tangentially

Answer: A

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4. The magnitude of the de-Broglie wavelength (λ) of an electron (e),proton(p),neutron (n) and α particle (a) all having the same energy of Mev, in the increasing order will follow the sequence:

A. $\lambda_e, \lambda_p, \lambda_n, \lambda_\alpha$

B. $\lambda_e, \lambda_n, \lambda_p, \lambda_\alpha$

C. $\lambda_{\alpha}, \lambda_{n}, \lambda_{p}, \lambda_{e}$

D. $\lambda_{p}, \lambda_{e}, \lambda_{\alpha}, \lambda_{n}$

Answer: C

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5. A steel ball of mass m is moving with a kinetic energy K. The de-Broglie wavelength associated with the ball is

A. $\frac{h}{2mK}$

B. $\sqrt{\frac{h}{2mK}}$

C. $\frac{h}{\sqrt{2mK}}$

D. none of these

Answer: C

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6. An α -particle and a singly ionized ${}_4Be^8$ atom are accelerated through the same potential difference. Ratio of de-broglie wavelength-

A. $1:2$

B. $1:1$

C. $2:1$

D. $4:1$

Answer: B

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7. A particle of mass m is projected form ground with velocity u making angle θ with the vertical. The de Broglie wavelength of the particle at the highest point is

A. ∞

B. h/mu sin θ

C. h/mu $\cos\theta$

D. h/mu

Answer: B

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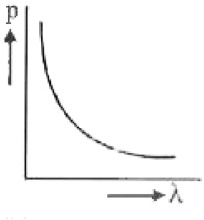
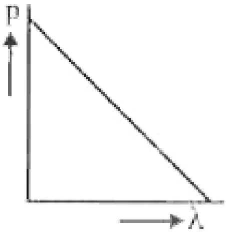
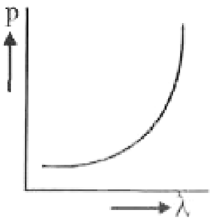
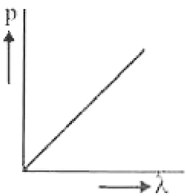
8. Which of the following figure represents the variation of particle momentum and the associated de - Broglie wavelength ?

A. 

B. 

C. 

D. 

Answer: A

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9. If the kinetic energy of the particle is increased to 16 times its previous value , the percentage change in the de - Broglie wavelength of the particle is

A. 25

B. 75

C. 60

D. 50

Answer: B

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10. A proton accelerated through a potential difference of 100V, has de-Broglie wavelength λ_0 . The de-Broglie wavelength of an α -particle, accelerated through 800V is

A. $\frac{\lambda_0}{\sqrt{2}}$

B. $\frac{\lambda_0}{2}$

C. $\frac{\lambda_0}{4}$

D. $\frac{\lambda_0}{8}$

Answer: D

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11. The de-Broglie wavelength of neutron in thermal equilibrium at temperature T is

A. $\frac{30.8}{\sqrt{T}} \text{Å}$

B. $\frac{3.08}{\sqrt{T}} \text{Å}$

C. $\frac{0.308}{\sqrt{T}} \text{Å}$

D. $\frac{0.0308}{\sqrt{T}} \text{Å}$

Answer: A

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12. A free particle with initial kinetic energy E, de-Broglie wavelength λ, enters a region where in it has a potential V, what is the new de-Broglie wavelength?

A. $\lambda(1 + E / V)$

B. $\lambda(1 - V / E)$

C. $\lambda(1 + V / E)^{0.5}$

D. $\lambda / (1 - V / E)^{0.5}$

Answer: D

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13. A proton has kinetic energy E = 100 keV which is equal to that of a photon. The wavelength of photon is λ_2 and that of proton is λ_1. The ratio of λ_2 / λ_1 is proportional to

A. E^2

B. $E^{1/2}$

C. E^{-1}

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

Answer: C

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14. The de-Brogile wavelength of a neutron at 927°C is λ. What will be its wavelength at 27°C?

A. $\frac{\lambda}{2}$

B. λ

C. 2λ

D. 4λ

Answer: C

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15. A proton and an α-particle are accelerated through same potential difference. Find the ratio of their de-Brogile wavelength.

A. $1:1$

B. $1:2$

C. $2:1$

D. $2\sqrt{2}:1$

Answer: D

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16. If $E_1, E_2 \text{and} E_3$ represent respectively the kinetic energies of an electron , an alpha particle and a proton each having same de Broglie wavelength then :

A. $E_1 > E_3 > E_2$

B. $E_2 > E_3 > E_1$

C. $E_1 > E_2 > E_3$

D. $E_1 = E_2 = E_3$

Answer: A

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17. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is

A. $\frac{-h}{eEt^2}$

B. $\frac{-eht}{E}$

C. $\frac{-mh}{eEt^2}$

D. $\frac{-h}{eE}$

Answer: A

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18. The photoelectron emitted from a metal surface are such that their velocity

A. is zero for all

B. is same for all

C. lies between zero and infinity

D. lies between zero and a finite maximum

Answer: D

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19. Light of a particular frequency v is incident on a metal surface. When the intensity of incident radiation is increased, the photoelectric current

A. decreases

B. increases

C. remains unchanged

D. sometimes increases and sometimes decreases

Answer: B

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20. Einstein's photoelectric equation is $E_k = hv - \phi$. In this equation E_k refers to

A. kinetic energy of all the emitted electrons

B. mean kinetic energy of emitted electrons

C. maximum kinetic energy of emitted electrons

D. minimum kinetic energy of emitted electrons

Answer: C

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21. Light of wavelength 3500Å is incident on two metals A and B whose work functions are 3.2 eV and 1.9 eV respectively. Which metal will emit photoelectrons

A. A

B. B

C. both A and B

D. neither A nor B

Answer: C

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22. The photoelectric work function for a metal surface is $4.125 eV$. The cut - off wavelength for this surface is

A. 4125Å

B. 3000Å

C. 6000Å

D. 2062Å

Answer: B

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23. When ultraviolet lightofenergy6.2 eV incidents on a aluminimum surface, it emits photoelectrons. If work function for aluminium surface is 4.2 eV, then kinetic energy of emitted electrons is

A. $3.2 \times 10^{-19} J$

B. $3.2 \times 10^{-17} J$

C. $3.2 \times 10^{-16} J$

D. $3.2 \times 10^{-11} J$

Answer: A

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24. The threshold frequency for a metallic surface corresponds to an energy of $6.2eV$ and the stopping potential for a radiation incident on this surface is $5V$. The incident radiation lies in

A. ultra-violet region

B. infra-red region

C. visible region

D. X-ray region

Answer: A

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25. In a photoelectric experiment the stopping potential for the incident light of wavelength 4000Å is 2 volt. If the wavelength be changed to 3000 Å, the stopping potential will be

A. 2V

B. zero

C. less than 2 V

D. more than 2 V

Answer: D

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26. In photoelectric effect, stopping potential for a light of frequency n_1 is V_1. If light is replaced by another having a frequency n_2 then its stopping potential will be

A. $V_1 - \frac{h}{e}(n_2 - n_1)$

B. $V_1 + \frac{h}{e}(n_2 + n_1)$

C. $V_1 + \frac{h}{e}(n_2 - 2n_1)$

D. $V_1 + \frac{h}{e}(n_2 - n_1)$

Answer: D

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27. Which metal will be suitable for a photo electric cell using light of wavelength 4000 Å. The work functions of sodium and copper are respectively 2.0 eV and 4.0 eV.

A. Sodium

B. Copper

C. Both

D. None of these

Answer: A

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28. Radiations of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successsively. The ratio of maximum velocities of photoelectrons emitted in two cases is

A. $1:2$

B. $1:3$

C. $1:4$

D. $1:1$

Answer: B

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29. A small photocell is placed at a distance of 4 m from a photosensitive surface. When light falls on the surface the current is 5 mA. If the distance of cell is decreased to 1 m, the current will become

A. $1.25 mA$

B. $\left(\frac{5}{16}\right) mA$

C. 20 mA

D. 80 mA

Answer: D

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30. In a photoelectric effect experiment, for radiation with frequency v_0 with hv_0 = 8eV, electrons are emitted with energy 2 eV. What is the energy of the electrons emitted for incoming radiation of frequency 1.25 v_0?

A. 1eV

B. 3.25 eV

C. 4eV

D. 9,25 eV

Answer: C

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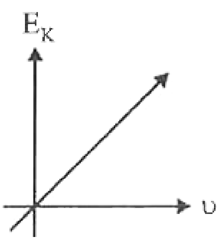
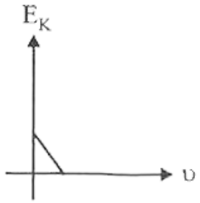
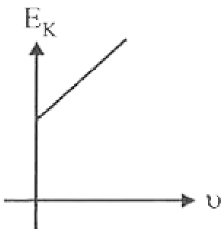
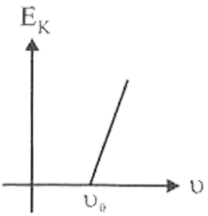
31. Which one of the following graphs represents the variation of maximum kinetic energy (E_K) of the emitted electrons with frequency u in photoelectric effect correctly ?

A. 

B. 

C. 

D. 

Answer: D

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32. A source of light is placed at a distance of 50 cm from a photocell and the stopping potential is found to be V_0 . If the distance between the light source and photocell is made 25 cm, the new stopping potential will be

A. $2V_0$

B. $V_0 / 2$

C. V_0

D. $4V_0$

Answer: C

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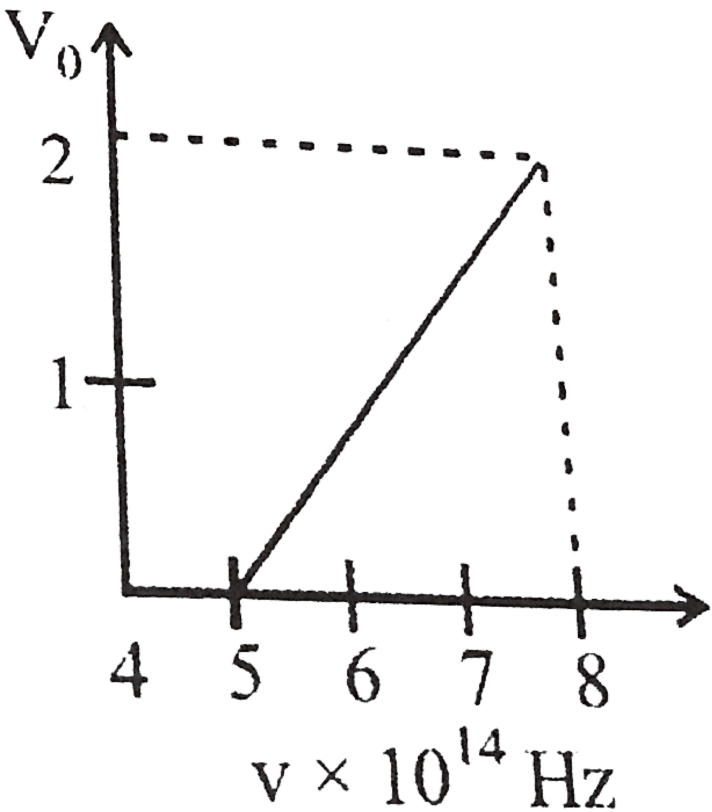
33. The stopping potential (V_0) versus frequency (v) plot of a substance is shown in figure, the threshold wavelength is



A. $5 \times 10^{14} m$

B. 6000Å

C. 5000Å

D. Cannot be estimated from given data

Answer: B

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34. The work functions of metals A and B are in the ratio $1:2$. If light of frequencies f and $2f$ are incident on the surfaces of A and B respectively , the ratio of the maximum kinetic energy of photoelectrons emitted is (f is greater than threshold frequency of $A, 2f$ is greater than threshold frequency of B)

A. $1:1$

B. $1:2$

C. $1:3$

D. $1:4$

Answer: B

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35. When a metal surface is illuminated by light wavelengths $400nm$ and $250nm$, the maximum velocities of the photoelectrons ejected are v and $2v$ respectively . The work function of the metal is

$(h = \text{Planck's constant}, c = \text{velocity of light in air})$

A. $2hc \times 10^6 J$

B. $1.5hc \times 10^6 J$

C. $hc \times 10^6 J$

D. $0.5hc \times 10^6 J$

Answer: A

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36. In a photoelectric experiment, with light of wavelength λ , the fastest electron has speed v. If the exciting wavelength is changed to $5\frac{\lambda}{4}$, the speed of the fastest emitted electron will become

A. $v\sqrt{\frac{5}{4}}$

B. $v\sqrt{\frac{5}{3}}$

C. less than $v\sqrt{\frac{5}{3}}$

D. greater than $v\sqrt{\frac{5}{3}}$

Answer: D

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37. Two identical photocathodes receive light of frequencies f_1 and f_2. If the velocities of the photo electrons (of mass m) coming out are respectively v_1 and v_2 then

A. $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

B. $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{1/2}$

C. $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$

D. $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

Answer: A

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38. In a photoelectric effect measurement, the stoppingg potential for a given metal is found to be V_0 volt, when radiation of wavelength λ_0 is used. If radiation of wavelength $2\lambda_0$ is used with the same metal, then the stopping potential (in V) will be

A. $\frac{V_0}{2}$

B. $2V_0$

C. $V_0 + \frac{hc}{2e\lambda_0}$

D. $-\frac{hc}{2e\lambda_0}$

Answer: D

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39. A photo cell is illuminated by a small bright source placed 1m away When the same source of light is placed 2m away, the electrons emitted by photo cathode

A. $1/8$

B. $1/16$

C. $1/2$

D. $1/4$

Answer: D

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40. For intensity I of a light of wavelength 5000Å the photoelectron saturation current is $0.40\mu A$ and stopping potential is $1.36V$, the work function of metal is

A. 2.47 eV

B. 1.36 eV

C. 1.10 eV

D. 0.43 eV

Answer: C

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41. The maximum velocity of the photoelectrons emitted from the surface is v when light of frequency n falls on a metal surface. If the incident frequency is increased to 3n, the maximum velocity of the ejected photoelectrons will be:

A. less than $\sqrt{3}v$

B. v

C. more than $\sqrt{3}v$

D. equal to sqrt3v`

Answer: C

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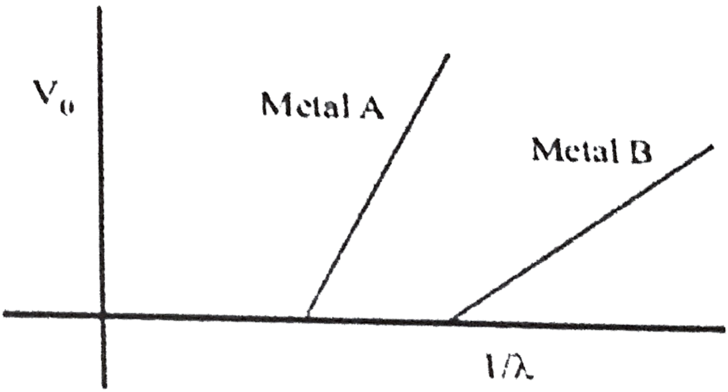
42. In an experiment on photoelectric effect, a student plots stopping potential V_0 against reciprocal of the wavelength λ of the incident light for two different metals A and B. These are shown in the figure



Looking at the graphs, you can most appropriately say that :

A. Work function of metal B is greater than that of metal A

B. For light of certain wavelength falling on both metal, maximum kinetic energy of electrons emitted from A will be greater than those emitted from B.

C. Work function of metal A is greater than that of metal B

D. Students data is not correct

Answer: D

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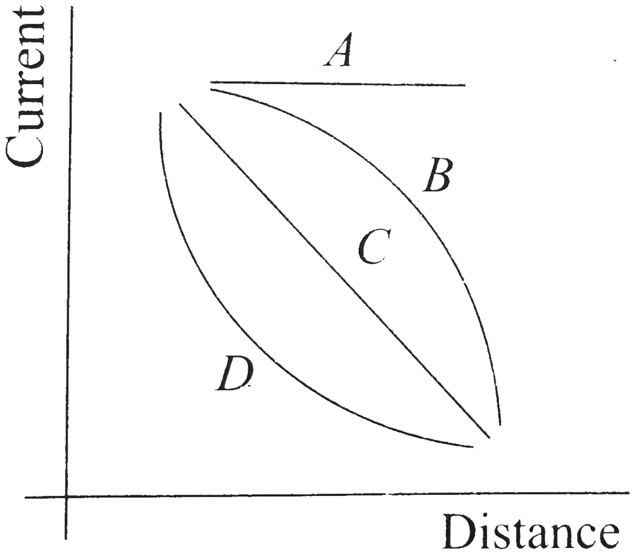

43.

A point source causes photoelectric effect from a small metal plate. Which of the curves in Fig. may represent the saturation photo-current as a function of the distance between the source and the metal?

A. A

B. B

C. C

D. D

Answer: D

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44. In a photoelectric experiment, the wavelength of the incident light is decreased from $6000A$ to

$4000 A$. While the intensity of radiations remains the same,

A. the cut-off potential will decrease

B. the cut-off potential will remain unchanged

C. the photoelectric current will remain unchanged

D. the kinetic energy of the emitted electrons will increase

Answer: D

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45. When a point light source, of power W, emitting monochromatic light of wavelength λ is kept at a distance a from a small photosensitive surface of work function ϕ and area S. Then

A. number of photons striking the surface per unit time as W$\lambda S / 4\pi hca^2$

B. the maximum energy of the emitted photoelectrons as $(1/\lambda)(hc - \lambda\phi)$

C. the stopping potential needed to stop the most energetic emitted photoelectrons as $(e/\lambda)(hc - \lambda\phi)$

D. photo - emission only if a lies in the range

$$0 \leq 1 \leq (hc/\phi)$$

Answer: C

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46. Find the number of photons emitted per second by a 25 W source of monochromatic light of wavelength 6600Å. What is the photoelectric current assuming 3% efficiency for photoelectric effect. Given $h = 6.6 \times 10^{-34} Js$.

A. $\frac{25}{3} \times 10^{19} J$, 0.4amp

B. $\frac{25}{4} \times 10^{19} J$, 6.2 amp

C. $\frac{25}{2} \times 10^{19} J$, 0.8 amp

D. none of these

Answer: A

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47. X-rays are

A. stream of electron

B. stream of positively charged particle

C. electromagnetic radiations of high frequency

D. stream of unchanged particles

Answer: C

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48. The ratio of the energy of an X - ray photon of wavelength 1 Å to that of visible light of wavelength 5000 Å is

A. $1 : 5000$

B. $5000 : 1$

C. $1 : 25 \times 10^6$

D. 25×10^6

Answer: B

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49. X-ray beam can be deflected

A. by a magnetic field

B. by an electric field

C. by both fields

D. neither by electric nor by magnetic fields

Answer: D

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50. White X-rays are called 'white' due to the fact that:

A. they are electromagnetic radiations having nature same as that of white light,

B. they are produced most abundantly in X ray tubes

C. they have a continuous wavelength range.

D. they can be converted to visible light using coated screens and photographic plates are affected by them just like light.

Answer: C

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51. X-rays are used to irradiate sodium and copper surfaces in two separate experiments and stopping potential are determined. The stopping potential is

A. equal in both cases

B. greater for sodium

C. greater for copper

D. infinite in both cases

Answer: B

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52. The intensity (I) of X-rays after traversing a distance x through a matter is related to the coefficient of absorption (μ) of the material as

A. $I = I_0 e^{\mu x}$

B. $I = I_0 e^{-\mu x}$

C. $I = e^{\mu x} / I_0$

D. $I = e^{\mu x} / I_0$

Answer: B

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53. When the minimum wavelength of X-rays is 2Å then the applied potential difference between cathode and anticathode will be

A. 6.2 kV

B. 2.48kV

C. 24.8kV

D. 62kV

Answer: A

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54. On operating an X-ray tube at 1 kV. X-rays of minimum wavelength 6.22Å are producd. I fht tube is operated at $10kV$, then the minimum wavelength of X-rays prodcued will be

A. 0.622Å

B. 6.22Å

C. 3.11Å

D. 0

Answer: A

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55. The X-rays of wavelength 0.5 A are scattered by a target. What will be the energy of incident X-rays, if these are scattered at an angle of 72° ?

A. 12.41

B. 6.2 KeV

C. 18.6 keV

D. 24.82 keV

Answer: D

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56. Which one of the following statement is $WRONG$ in the context of X- rays generated from X- rays tube ?

A. Wavelength of characteristic X-rays decreases when the atomic number of the target increases.

B. Cut-off wavelength of the continuous X-rays depends on the atomic number of the target

C. Intensity of the characteristic X-rays depends on the electrical power given to the X-ray tube

D. Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in the X-ray tube

Answer: B

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57. The potential difference applied to an X-ray tube is 5 kV and the current through it is 3.2 mA.

Then the number of electros striking the target par second is

A. 2×10^{16}

B. 5×10^{6}

C. 1×10^{17}

D. 4×10^{15}

Answer: A

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58. An X-ray tube is operated at 15 kV. Calculate the upper limit of the speed of the electrons striking the target.

A. $7.26 \times 10^7 m / s$

B. $7.62 \times 10^7 m / s$

C. $7.62 \times 10^7 cm / s$

D. $7.26 \times 10^9 m / s$

Answer: A

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59. X- rays are produced in an X- rays tube operating at a given accelerating voltage . The wavelength of the continuous X- rays has values from

A. 0 to ∞

B. $\lambda_{\min}$ to ∞, where, $\lambda_{\min} > 0$

C. 0 to $\lambda_{\max}$, where $\lambda_{\max} < \infty$

D. 0 to $\lambda_{\max}$, where $0 < \lambda_{\min} < \lambda_{\max} < \infty$

Answer: B

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60. An X-ray tube with Cu target is operated at 25 kV. The glancing angle for a NaCl. Crystal for the Cuk_α line is 15.8° . Find the wavelength of this line.

A. 3.06Å

B. 1.53Å

C. 0.75 Å

D. none of these

Answer: B

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Exercise 2 Concept Allplicator

1. When photon of wavelength λ_1 are incident on an isolated shere supended by an insulated , the corresponding stopping potential is found to be V. When photon of wavelength λ_2 are used , the orresponding stopping potential was thrice the above value. If light of wavelength λ_3 is used , carculate the stopping potential for this case.

A. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

B. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right]$

C. $\frac{hc}{e}\left[\frac{1}{\lambda_3}-\frac{3}{2\lambda_2}+\frac{1}{2\lambda_1}\right]$

D. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{2\lambda_1}\right]$

Answer: C

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2. A photosensitive metallic surface has work funtion hv_0. If photons of energy $2hv_0$ fall on this surface the electrons come out with a maximum velocity of $4 \times 10^6 m/s$. When the photon energy is increases to $5hv_0$ then maximum velocity of photo electron will be

A. $2 \times 10^7 m/s$

B. $2 \times 10^6 m/s$

C. $8 \times 10^6 m/s$

D. $8 \times 10^5 m/s$

Answer: C

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3. A $5W$ source emits monochromatic light of wavelength $5000Å$. When placed $0.5m$ away , it liberates photoelectrons from a photosensitive metallic surface . When the source is moved to a distance of $1.0m$ the number of photoelectrons liberated will be reduced by a factor of

A. 8

B. 16

C. 2

D. 4

Answer: D

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4. When a certain metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential for photoelectric current is $3V_0$ and when the same surface is illuminated with light of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectrice effect is

A. 4λ

B. 3.5λ

C. 3λ

D. 2.75λ

Answer: A

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5. Light from a hydrogen tube is incident on the cathode of a photoelectric cell the work function of the cathode surface is $4.2eV$. In order to reduce the photo - current to zero the voltage of the anode relative to the cathode must be made

A. $-4.2V$

B. $-9.4V$

C. $-17.8V$

D. $+9.4V$

Answer: B

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6. Electron are accelerated through a potential difference V and protons are accelerated through a potential difference of 4 V. The de-Broglie wavelength are λ_e and λ_p for electrons and protons, respectively The ratio of $\frac{\lambda_e}{\lambda_p}$ is given by (given , m_e is mass of electron and m_p is mass of proton)

A. $\frac{\lambda_e}{\lambda_p}=\sqrt{\frac{m_p}{m_e}}$

B. $\frac{\lambda_e}{\lambda_p}=\sqrt{\frac{m_e}{m_p}}$

C. $\frac{\lambda_e}{\lambda_p}=\frac{1}{2}\sqrt{\frac{m_e}{m_p}}$

D. $\frac{\lambda_e}{\lambda_p}=2\sqrt{\frac{m_p}{m_e}}$

Answer: D

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7. A metal surface is illuminated by light of two different wavelengths 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are μ_1 and μ_2 respectively. If the ratio $u_1 : u_2 = 2:1 \text{ and } hc = 1240eV$, the work function of the metal is nearly.

(a)3.7 eV (b) 3.2 eV

(c) 2.8eV (d) 2.5eV.

A. 3.7 eV

B. 3.2 eV

C. 2.8 eV

D. 2.5 eV

Answer: A

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8. A beam of light has three wavelengths 4144Å, 4972Å and 6216Å with a total instensity of $3.6 \times 10^{-3} Wm^{-2}$ equally distributed amongst the three wavelengths. The beam falls normally on an area $1.0 cm^2$ of a clean metallic surface of work function 2.3 eV. Assume that there is no loss of light by reflection and that each energetically capable photon ejects on electron. Calculate the number of photo electrons liberated in two seconds.

A. 6×10^{11}

B. 9×10^{11}

C. 11×10^{11}

D. 15×10^{11}

Answer: B

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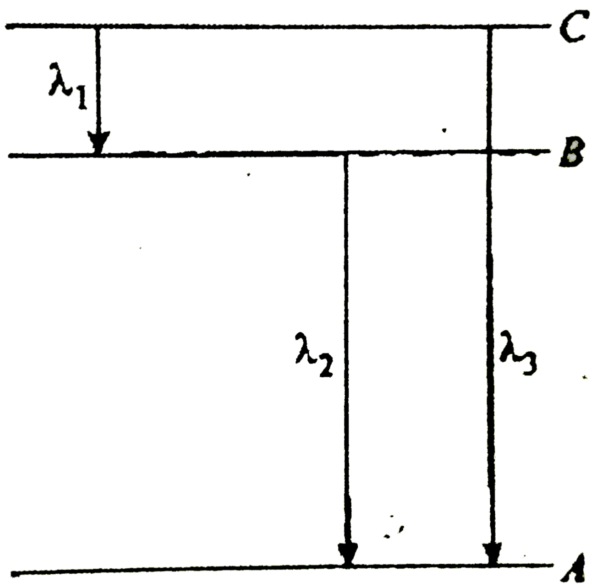
9. Energy levels A,B and C of a certain atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$ .If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiation corresponding to transition C to B,B to A and C to A respectively, which of the following statements is correct ?



A. $\lambda_3 = \lambda_1 + \lambda_2$

B. $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

C. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

D. $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Answer: B

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10. A copper ball of radius 1 cm and work function 4.47eV is irradiated with ultraviolet radiation of wavelength 2500 Å. The effect of irradiation results in the emission of electrons from the ball, Further the ball will acquire charge and due to this there will be a finite value of the potential on the ball. The charge acquired by the ball is :

A. $5.5 \times 10^{-13} C$

B. $7.5 \times 10^{-13} C$

C. $4.5 \times 10^{-12} C$

D. $2.5 \times 10^{-11} C$

Answer: A

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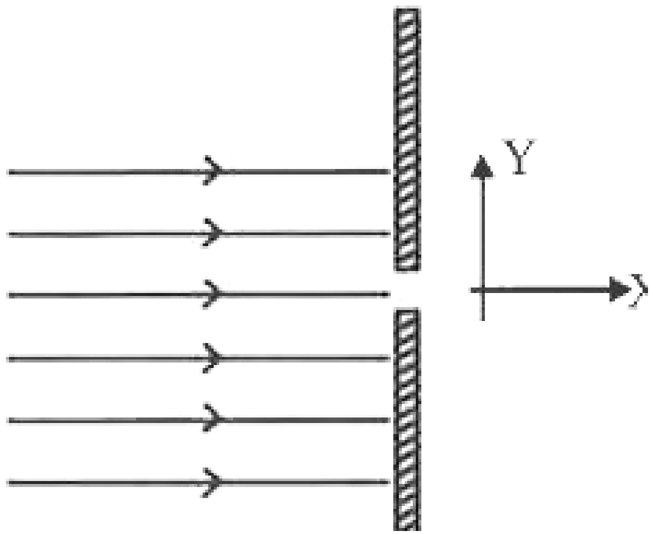
11. A parallel beam of electrons travelling in x-direction falls on a slit of width d (see figure). If after passing the slit, an electron acquires momentum p_y in the y-direction then for a majority of electrons passing through the slit (h is Planck's constant):



A. $|P_y|d > h$

B. $|P_y|d < h$

C. $|P_y|d = h$

D. $|P_y|d > \; > h$

Answer: A

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12. Light of wavelength $0.6\mu m$ from a sodium lamp falls on a photocell and causes the emission of photoelectrons for which the stopping potential is 0.5V. With light of wavelength $0.4\mu m$ from a murcury vapor lamp, the stopping potential is $1.5V$. Then, the work function [in electron volts] of the photocell surface is

A. 0.75 eV

B. 1.5 eV

C. 3 eV

D. 2.5 eV

Answer: B

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13. An electron is accelerated through a potential difference of V volt. It has a wavelength λ associated with it. Through what potential difference an electron must be accelerated so that its de Broglie wavelength is the same as that of a proton? Take massof proton to be 1837 times larger than the mass of electron

A. V volt

B. 1837 V volt

C. V/1837 volt

D. $\sqrt{1837V}$ volt

Answer: C

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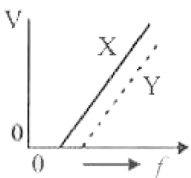
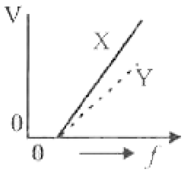
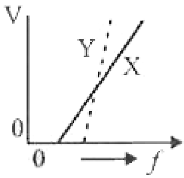
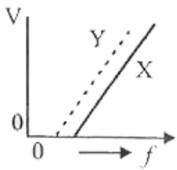
14. In a photoelectric emission, electrons are ejected from metals X and Y by light of frequency f. The potential difference V required to stop the electrons is measured for various frequencies. If Y has a greater work function than X, which graph illustrates the expected results.

A. 

B. 

C. 

D. 

Answer: A

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15. A homogeneous ball (mass=m) of ideal black material at rest is illuminated with a radiation having a set of photons (wavelength $= \lambda$), each with the same momentum and the same energy. The rate at whoch photons fall on the ball is n. the linear acceleration of the ball is

A. $m\lambda / nh$

B. $nh / m\lambda$

C. $nh / (2\pi)(m\lambda)$

D. $(2\pi m\lambda / nh$

Answer: B

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16. Light of wavelength λ from a small 0.5 mW He-Ne laser source, used in the school laboratory, shines from a spacecraft of mass 1000 kg. Estimate the time needed for the spacecraft to reach a velocity of $1.0 km^{-1}$ from rest. The momentum p of a photon of wavelength λ is given by $p = \frac{h}{\lambda}$, where h is Planck's constant.

A. 6×10^{18}

B. 3×10^{17}

C. 6×10^{17}

D. 2×10^{15}

Answer: C

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17. A photon and an electron posses same de-Broglie wavelength. Given that c= speed of light and v=speed of electron, which of the following relations is correct? Here $E_e = KE$ of elecron, $E_{ph} = KE$ of photon, $p_e = momentumofe \le ctron$, p_(ph)` = momentum of photon:

A. $E_e / E_{ph} = 2C / v$

B. $E / E_{ph} = v / 2C$

C. $P_e / P_{ph} = 2C / v$

D. $P_e / P_{ph} = C / v$

Answer: B

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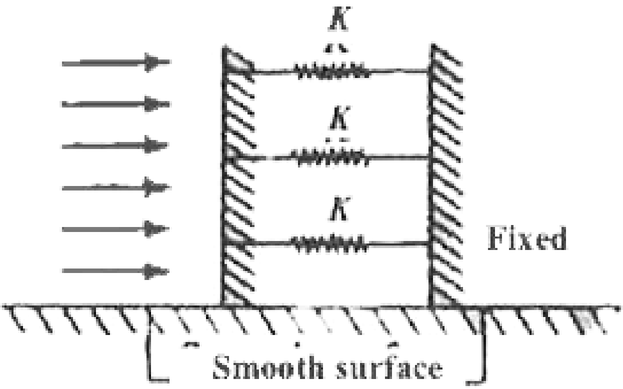
18. Light of intensity I is incident perpendicularly on a perfectly reflecting plate of area A kept in a gravity free space. If the photons strike the plate symmetrically and initially the spring was at its natural length, find the maximum compression in the springs.



A. IA/Kc

B. 2Ia/3Kc

C. 3Ia/Kc

D. 4Ia/3Kc

Answer: D

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19. What will be the ratio of de - Broglie wavelengths of proton and α - particle of same energy ?

A. $\sqrt{2}:1$

B. $2\sqrt{2}:1$

C. $2:1$

D. $4:1$

Answer: C

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20. A sensor is exposed for time t to a lamp of power P placed at a distance l. The sensor has an opening that is 4d in diameter. Assuming all energy of the lamp is given off as light, the number of photons entering the sensor if the wavelength of light is λ is:

A. $N = P\lambda d^2 t / hcl^2$

B. $N = 4P\lambda d^2 t / hcl^2$

C. $N = P\lambda d^2 t / 4hcl^2$

D. $N = P\lambda d^2 t / 16hcl^2$

Answer: A

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21. When X- ray of wavelength 0.5 Å pass through 7 mm thick aluminium sheet then their intensity reduces to one fourth. Find coefficient of absorbtion of aluminium for these X-rays.

A. $0.188mm^{-1}$

B. $0.189mm^{-1}$

C. $0.198mm^{-1}$

D. none of these

Answer: C

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22. A source S_1 is producing 10^{15} photons/s of wavelength 5000Å Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100Å. Then $(\text{power of}$S_(2))/("power of" S_(1))` is equal to

A. 1

B. 1.02

C. 1.04

D. 0.98

Answer: A

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23. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface , having work function $5.01eV$, when ultraviolet light of $200nm$ falls on it , must be

A. 2.4V

B. $-1.2V$

C. $-2.4V$

D. 1.2 V

Answer: D

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24. If the momentum of electron is changed by P_m then the de-Broglie wavelength associated with it changes by 0.50%. The initial momentum of electron will be:

A. 200P

B. 400P

C. P/200

D. 100P

Answer: A

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25. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is

A. $1:4$

B. $1:2$

C. $1:1$

D. $1:5$

Answer: B

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26. A modern 200 W sodium street lamp emits yellow light of wavelength 0.6 μm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is

A. 1.5×10^{20}

B. 6×10^{18}

C. 62×10^{20}

D. 3×10^{19}

Answer: A

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27. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV. The work function of the metal is:

A. 0.65 eV

B. 1.0 eV

C. 1.3 eV

D. 1.5eV

Answer: B

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28. Light of wavelength λ_A and λ_B falls on two identical metal plates A and B respectively . The maximum kinetic energy of photoelectrons in K_A and K_B respectively , then which one of the following relations is true ? $(\lambda_A = 2\lambda_B)$

A. $K_A < \frac{K_B}{2}$

B. $2K_A = K_B$

C. $K_A = 2K_B$

D. $K_A > 2K_B$

Answer: A

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29. An electron of mass m and a photon have same energy E. The ratio of de - Broglie wavelengths associated with them is :

A. $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

B. $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

C. $c(2mE)^{\frac{1}{2}}$

D. $\frac{1}{xc}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$

Answer: A

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30. When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V. If the same surface is illuminated with radiation of wavelength 2λ , the stopping potential is $\frac{V}{4}$. The threshold wavelength surface is :

A. 4λ

B. 5λ

C. $\frac{5}{2}\lambda$

D. 3λ

Answer: D

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