PHYSICS

BOOKS - PRADEEP PHYSICS (HINGLISH)

DUAL NATURE OF RADIATION AND MATTER

Solved Examples

1. The work function of cesium is 2.14 eV. Find (a) the threshold frequency for cesium, and (b) the wavelength of the incident light if the photo current is brought to zero by a stopping potential 0.60 V. Given $h = 6.63 \times 10^{-34} Js.$

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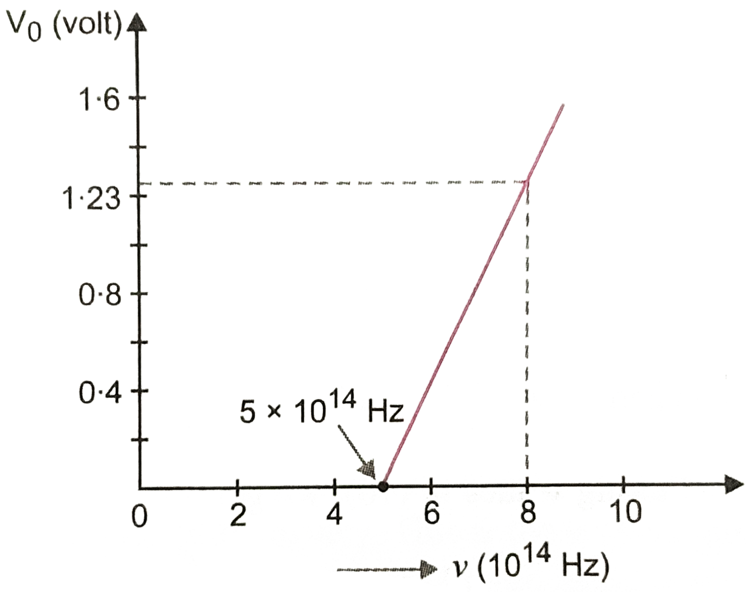
2. Using the graph shown in fig for stopping potential v_s the incident frequency of photons, calculate Planck's constant.



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3. The momentum of photon of electromagnetic radiation is $3.3 \times 10^{-29} kgms^{-1}$. What is the frequency and wavelength of the waves associated with it ? $h = 6.6 \times 10^{-34} Js$.

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4. Find the number of emitted per minute by a 25W source of monochromatic light of wavelength 5000Å. Use $h = 6.63 \times 10^{-34} Js.$

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5. What is the de-Broglie wavelength associated with (a) an electron moving with speed of $5.4 \times 10^{6} ms^{-1}$, and (b) a ball of mass 150g travelling at $30.0 ms^{-1}$? $h = 6.63 \times 10^{-34} Js$, mass of electron $= 9.11 \times 10^{-31} kg.$

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6. The equivalent wavelength of a moving electron has the same value as that of a photon having an energy of $6 \times 10^{-17} J$. Calculate the momentum of the electron.

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7. Through what potential difference should an electron be accelerated so that its de-Broglie wavelength becomes 0.4Å?

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8. Find the de-Broglie wavelength of an electron in a metal at $127^{\circ} C$. Given, mass of electron $= 9.11 \times 10^{-31} kg$, Boltsmann constant $= 1.38 \times 10^{-23} \text{J mole}^{-1} K^{-1}$, Plank constant $= 6.63 \times 10^{-34} Js$.

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9. The work function (ϕ_0), of a metal X, equals $3 \times 10^{-19} J$. Calculate the number (N) of photons, of light of wavelength 26.52nm, whose total energy equal W. Plank's constant $= 6.63 \times 10^{-34} Js$.

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10. The work function for the following metals is given Na: 2.75 eV, K:2.30 eV , Mo: 4.17 eV , Ni: 515 eV.

Which of these metals will not give photoelectric emission for a radiation of wavelength 3300 A from a $He - Cd$ laser placed 1m away from the photocell? What happens if the laser is brought nearer and placed 50 cm away?

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11. By how which would the stopping potential for a given photosensitive surface go up if the frequency of the incident radiations were to be increased from $4 \times 10^{15} Hz$ to $8 \times 10^{15} Hz$? Given, $h = 6.6 \times 10^{-34} Js$, $e = 1.6 \times 10^{-19} C$ and $c = 3 \times 10^{8} ms^{-1}$.

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12. Work function of sodium is 2.3 eV. Does sodium show photoelectric emission for orange light $(\lambda = 6800\text{Å})$?

Given $h = 6.63 \times 10^{-34} Js$

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13. A metal has a work function of 2.0 eV and is illuminated by monochromatic light of wavelength 500nm. Calculate (a) the threshold wavelength (b) the maximum energy of photoelectrons (c) the stopping potential. [use h=$6.63 \times 10^{-34} J, c = 3 \times 10^{8} ms^{-1}$]

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14. The work fuction of caseium is 2.14 eV. Find (a) the threshold frequency for caesium and (b) the wavelength of the incident light if the photocurrent is brought to zero by a stopping potential of 0.60V. Given $h = 6.63 \times 10^{-34} Js.$

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15. The work function for a metal is 1.8eV. Light of 5000Å is incident on it. Calculate (a) threshold frequency and threshold wavelength, (b) maximum kinetic energy of the emitted electrons, (c) maximum velocity of the emitted electrons, (d) if the intensity of the incident light be doubled, then what will be the maximum kinetic energy of the emitted electrons? given, $h = 6.63 \times 10^{-34} Js, m_e = 9 \times 10^{-31} kg, c = 3 \times 10^8 ms^{-1}$.

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16. Photoelectrons are emitted from a metal surface when ultraviolet light of wavelength 300nm is incident on it. The minimum negative potential required on it. The minimum negative potential required to stop the emission of electrons is 0.54V. Calculate:

(i) the energy of the incident photons

(ii) the maximum kinetic energy of the photoelectrons emitted

(iii) the work function of the metal Express all answer in eV. $(use h = 6.63 \times 10^{-34} Js)$

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17. By how which would the stopping potential for a given photosensitive surface go up if the frequency of the incident radiations were to be increased from $6 \times 10^{15} Hz$ to $16 \times 10^{15} Hz$? Given, $h = 6.6 \times 10^{-34} Js$, $e = 1.6 \times 10^{-19} C$ and $c = 3 \times 10^{8} ms^{-1}$.

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18. Light of wavelength 5000Å falls on a metal surface of work function 1.9eV. Find (i) the energy of photons in eV (ii) the kinetic energy of photoelectrons and (iii) the stopping potential. Use $h = 6.63 \times 10^{-34} Js$, $c = 3 \times 10^{8} ms^{-1}, e = 1.6 \times 10^{-9} C$.

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19. (a) The work function for the surface of aluminum is 4.2eV. How much potential difference will be required to stop the emission of maximum energy electrons emitted by light of 2000Å wavelength?

(b) What will be the wavelength of that incident light for which stopping potential will be zero ? $h = 6.6 \times 10^{-34} Js, c = 3 \times 10^8 ms^{-1}$.

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20. (a) The work function for the surface of aluminium is 4.2eV. Find potential difference will be required to stop the emission of maximum kinetic energy photoelectrons emitted by light of 1800Å wavelenght?

(b) Determine the wavelength of that incident light for which stopping potential will be zero? $\left(h = 6.6 \times 10^{-34}\right)$

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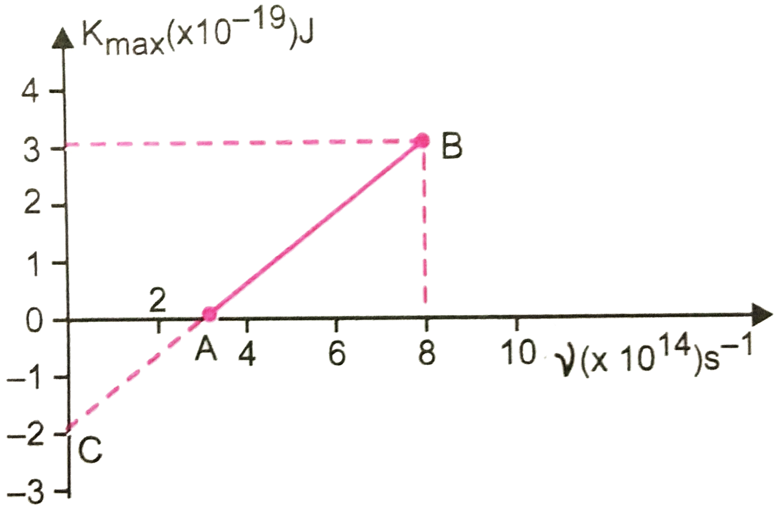
21. In an experiment on photoelectic effect, the graph between maximum kinetic energy $(K_{\max})$ and frequency of emitted photoelectron from metal surface is found to be a straight line as shown in fig. Calculate



(a) thereshold frequency.

(b) work function of metal in electron volt.

(c) Planck's constant and

maximum kinetic energy of the emitted electron by light of frequency $v = 8 \times 10^{14} s^{-1}$.

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22. When a piece of metal is illuminated by monochromatic light of wavelength λ then the stopping potential for photoelectric current is 2.5 V_0. When the same surface is illuminated by light of wavelength 1.5 λ, then the stopping potential becomes V_0. Find the value of threshold wavelength for photoelctric emission.

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23. A monochromatic source of light operating at 500W emits 6×10^{20} photon per second. Find the wavelength of the light used. Use $h = 6.6 \times 10^{-34} Js, C = 3 \times 10^8 m/s$

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24. Monochromatic light of frequency $6.0 \times 10^{14} Hz$ is produced by a laser. The power emitted is $2.0 \times 10^{-3} W$, (a) What is the energy of a photon in the light beam? (b) How many photons per second, on the average, are emitted by the source? Given $h = 6.63 \times 10^{-34} Js$

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25. A monochromatic source emitting light of wavelength, 600nm, has a power output of 66W. Caculate the number of photons emitted by this source in 2minuts. Use $h = 6.6 \times 10(- 34)Js.$

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26. How many photons are received on earth per cm^{-2} per hour if the energy from the sun reaching on the earth is at the rate of $2calcm^{-2}\min^{-1}$ and average wavelength of solar light be taken as 5500Å. Use $h = 6.6 \times 10^{-34}J, c = 3 \times 10^8 ms^{-1}$ and $1cal = 4, 2J$

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27. If 10% of the energy supplied to an incandescent light bulb is radiated as visible light, how many visible light photons are emitted by 200watt bulb? Assume wavelength of all visible photons to be 5000Å. Given $h = 6.6 \times 10^{-34}Js.$

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28. The wavelength of light in the visible region is about 390nm for violet colour, about 550nm (average wavelength) for yellow green colour and about 760nm for red colour. What are the energies of photon in eV at the (i) violet end (ii) average wavelength yellow-green colour and (iii) red end of the visible spectrum? $\left(\text{Take } h = 6.63 \times 10^{-34} Js \text{ and } 1eV = 1.6 \times 10^{-19} Js\right)$

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29. The kinetic energy of the electron orbiting in the first excited state of hydrogen atom is 3.4 eV. Determine the de- broglie wavelength associated with it.

Mass of electron=$9.1 \times 10^{-31} kg$,

Planck's constant=$6.63 \times 10^{-34} Js$.

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30. The wavelength λ of a photon and the de-Broglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of the electron, Where m,c and h have their usual meanings.

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31. The equivalent wavelength of a moving electron has the same value as that of a photon having an energy of $6 \times 10^{-17} J$. Calculate the momentum of the electron.

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32. An electron, an α-particle, and a photon have the same kinetic energy. Which of these particles has the shortest, de -broglie wavelenght?

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33. A particle is moving three times as fast as an electron. The ratio of the de- Broglie wavelength of the particle to that of the electron is 1.813×10^{-4}. Calculate the particle's mass and identity the particle. Mass of electron $= 9.11 \times 10^{-31} kg.$

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34. What is the de-Broglie wavelength associated with an electron moving with an electron, accelerated through a potential difference of 100 volt?

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35. Find the de-Broglie wavelength (inÅ) associated with an electron moving with a velocity 0.6c, where $c = 3 \times 10^8 m/s$ and rest mass of electron $= 9.1 \times 10^{-31} kg, h = 6.63 \times 10^{-34} Js.$

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36. Find the de Broglie wavlength of a neutron at 127°C Given that Boltzmann's constant $k = 1.38 \times 10^{-23} J$ molecule^{-1} K^{-1}. Planck's constant $= 6.625 \times 10^{-34} Js$, mass of neutron $= 1.66 \times 10^{-27} kg$.

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37. For what kinetic energy of a proton, will the associated de-Broglie wavelength be 16.5nm? Mass of proton $= 1.675 \times 10^{-27} kg$, $h = 6.63 \times 10^{-34} Js$

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38. What is the de-Broglie wavelength of nitrogen molecule in air at 300K ? Assume that the molecule is moving with the root mean square speed fo molecules at this temperature. (Atomic mass of nitrogen $= 14.0076U$) Plank's constant=$6.63 \times 10^{-34} Js$, Boltzmann constant $= 1.38 \times 10^{-23} JK^{-1}$

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39. X-rays of wavelength 0.82Å fall on a metal plate. Find the wavelength associated with photoelectron emitted. Neglect work function of the metal.

Given $c = 3 \times 10^8 m / sh = 6.63 \times 10^{-34} Js.$

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40. Find the typical de-Broglie wavelength associated with a H-atom in helium gas at room temperature $(27^{\circ} C)$ and 1atm pressure, and compare it with the mean separation between two atom under these conditions.

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41. a. A stopping potential of $0.82V$ is required to stop the emission of photoelectrons from the surface of a metal by light of eavelength $4000A$. For light of wavelength $3000A$, the stopping potential is $1.85V$. Find the value of Planck's constant. [1 electrons volt (eV) $= 1.6 \times 10^{-19} J]$

b. At stopping potential, if the wavelength of the incident light is kept fixed at $4000A$, but the intensity of light increases two times, will photoelectric current be botained ? Give reasons for your answer.

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42. Light of wavelength 4000Å is incident on barium. Photoelectrons emitted describe a circle of radius 50 cm by a magnetic field of flux density $5.26 \times 10^{-6} tesla$. What is the work of barium in eV? Given $h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31} kg.$

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43. Calculate the strength of the transverse magnetic field required to bend all photoelectorns within a circle of radius 50 cm, when light of wavelength 4000Å is incident on a barium emitter. Work function of barium is 2.5eV. Given, $m_e = 9.1 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C, h = 6.6 \times 10^{-34} Js.$

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44. The extent of localization of a particle is determined roughly by its de Broglie wave. If an electron is localized within the nucleus (of size about 10^{14}m) of an atom, what is its energy? Compare this energy with the typical binding energies (of the order of a few MeV) in a nucleus and hence argue why electrons cannot reside in a nucleus.

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45. Radiations of frequency $10^{15} Hz$ is incident on three photosenstive surfaces. A,B and C. Following observations are recorded,

(a) Surface A. No photoemission occurs.

(b) Surface B. Photoemission occurs but the photoelectrons have zero kinetic energy.

(c) Surface C. Photoemission occurs and photoelectrons have some KE.

Based on Einstein's photoelectric equation, expalain the three observations.

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46. It is easier to remove an electron from sodium then from copper. Which metal has higher value of threshold frequency?

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47. Blue light can eject electrons from a photosenstive surface while orange light can not. Will violet and red light eject electrons from the same surfac?

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48. If the intensity of light falling on the emitting substance of a photoelectric cell be increased then what will be the effect on (i) current flowing from the cell, (ii) potential difference required to stop the current completely?

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49. When a metal surface is exposed with a monochromatic light, then all the photoelectrons are not emitted from the metal surface with the same kintetic energy. Why?

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50. For three different materials, the variation of the stopping potential V_0 and the wavelength λ of the incident light is shown by curves a,b and c in fig. which material has maximum work function and which one has least work function ?

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51. Draw a graph showing the variation of stopping potential with frequency of the incident radiation. What does the slope of the line with frequency axis indicate? What information can be obtained from the values of intercept on the potential axis?

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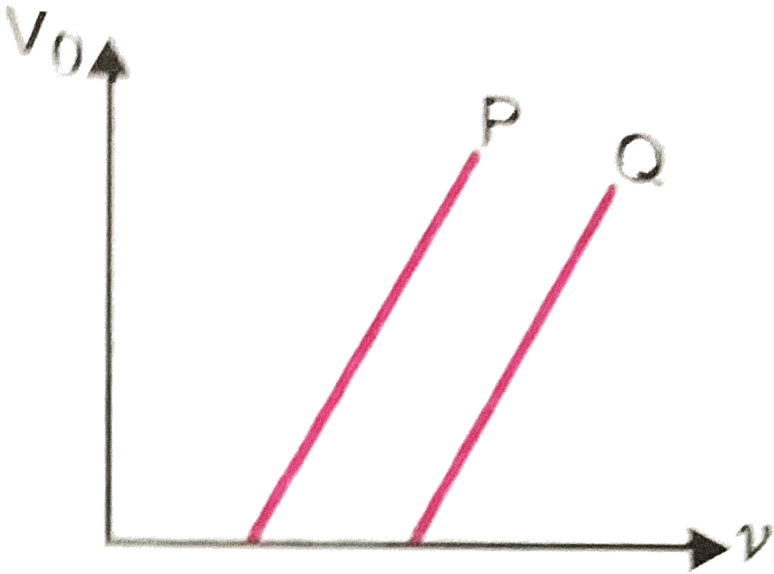
52. Fig. shows the variation of stopping potential V_0 with the frequency v of the incident radiation for two photosensitive metal P and Q:

(i) Explain which metal has smaller threshold wavelength



(ii) Explain, giving reason, which metal emits photoelectrons having smaller kinetic energy, for the same wavelength of incident radiation.

(iii) If the distance between the light source and metal P is doubled, how will the stopping potential change.

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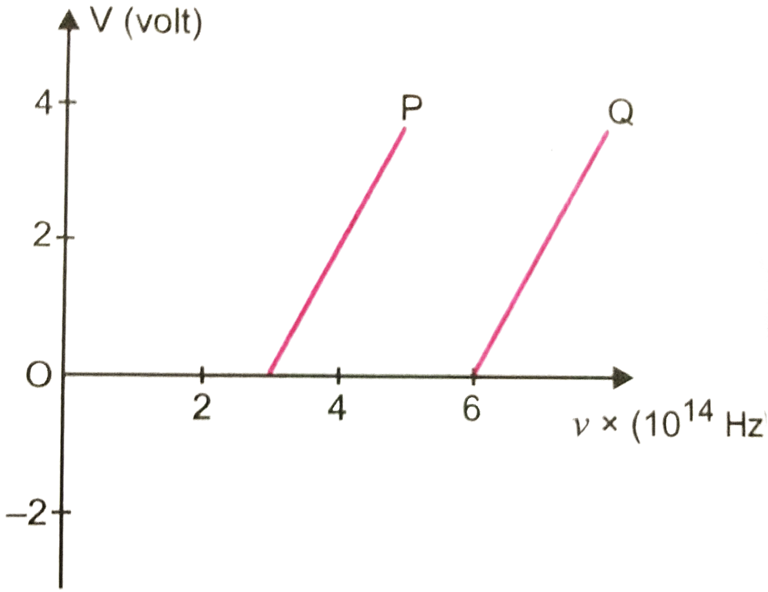
53. In the study of a photoelectric effect the graph between the stopping potential V and frequency v of the incident radiation on two different metals P and Q is shown in fig.

(i) which one of two metals have higher threshold frequency

(ii) Determine the work function of the metal which has greater value

(iii) Find the maximum kinetic energy of electron emitted by light of frequency $8 \times 10^{14} Hz$ for this metal.



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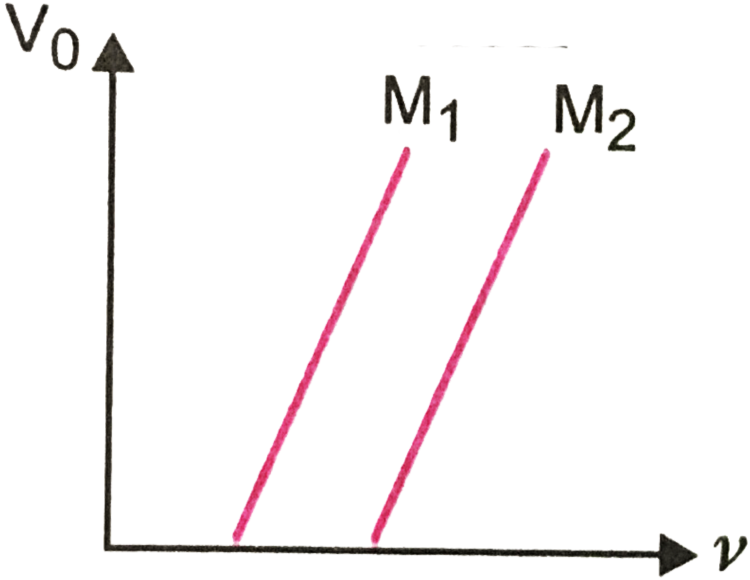
54. fig. shows variation of stopping potential (V_0) with frequency (v) for two photosenstive matrials M_1 and M_2.



(i) why is the slope same for both lines?

(ii) For which material will the emitted electrons have greater kinetic energy for the incident radiations of the same frequency? Justify your answer.

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55. Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies, $v_1 > v_2$ of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

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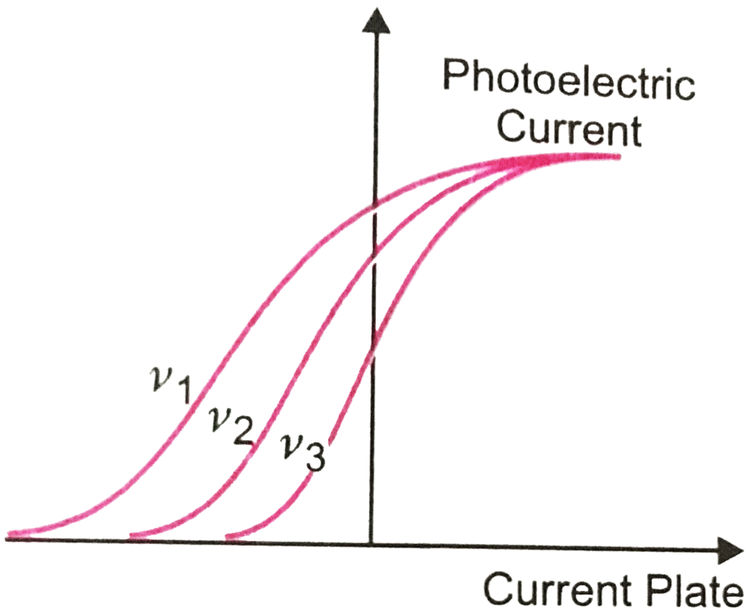
56. The graph of Fig. shows the variation of photoelectric current with collector plate potential for different frequencies of incident radiations.



(i) Which physical parameter is kept constant for the three curves?

(ii) Which frequency $(v_1, v_2 \text{ or } v_3)$ is the highest?

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57. A source of light is emitting photons. Does all the photons emitted have the same energy? Is the source monochromatic? Explain.

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58. A lamp mainly emits light of wavelength λ. The lamp is rated at P watt and 8% of the energy is emitted as visible light.

(i) How many photons of light are emitted by the lamp per second?

(ii) How many photons are falling per second on a square whose length of each side is a, held perpendicular to the incident photons at a distance r from the lamp.

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59. X-rays of wavelength λ fall on photosenstive surface, emitting electrons. Assuming that the work function of the surface can be neglected, prove that the de-broglie wavelength of electrons emitted will be $\sqrt{\frac{h\lambda}{2mc}}$.

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60. If an em wave of wavelength λ is incident on a photosenstive surface of negligible work function. If the photoelectrons emitted from this surface have the de-Broglie wavelength λ_1, prove that

$$\lambda = \left(\frac{2mc}{h}\right)\lambda_1^2$$

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61. X-ray fall on a photosenstive surface to cause photoelectric emission. Assuming that the work function of the surface can be neglected, find the relation between the de -Broglie wavelength (λ) of the electrons emitted to the energy (E_v) of the incident photons. Draw the nature of the graph for λ as a function of E_v.

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62. An electron and a photon have the same de Broglie wavelength. Which one of these has higher kinetic energy?

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63. A proton and an electron have same d-Broglie wavelength which of them moves fast and which possess more K.E. Justify your answer.

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64. Show that d-Broglie hypothesis of matter wave supports the Bohr's concept of stationary orbit.

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65. In the nth orbit of hydrogen atom, find the ratio of the radius of the electron orbit and de-Broglie wavelength associated with it.

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66. If the intensity of the incident light (whose frequency is greater than threshold frequency) is increased then explain its effect on (i) the maximum momentum that photoelectron could have and (ii) the minimum de -Broglie wavelength that photoelectron could have.

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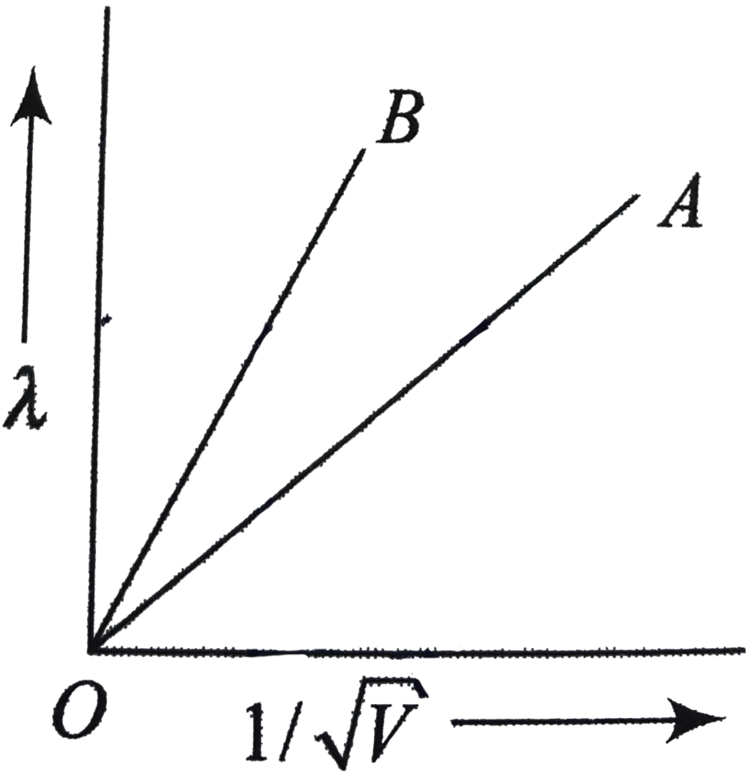

67.

The two lines A and B in fig. show the photo electron of de Broglie wavelength (λ) as a function of $\frac{1}{\sqrt{V}}$(V is the accelerating potential) for two particles having the same charge. Which of the two represents the particle of heavier mass?

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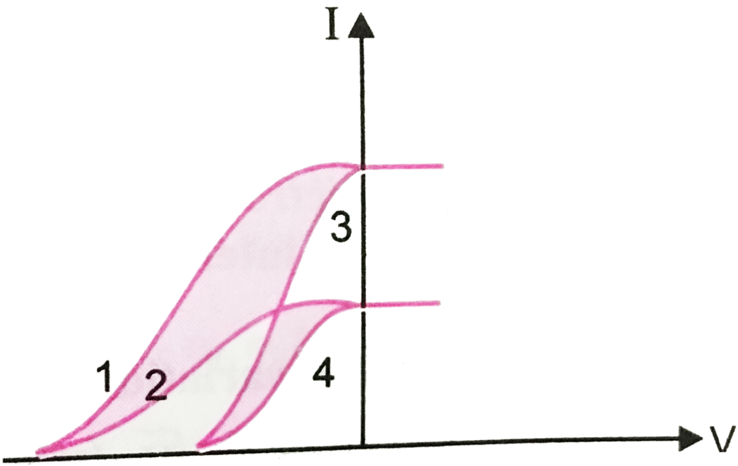
68. The graph of Fig. shows the variation of photoelectric current (I) versus applied voltage (V) for the two different photosensitive materials for two different intensities of the incident radiation. Identify the pairs of curves that correspond to different materials but same intensity of incident radiation.



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69. The threshold wavelength for photoelectric emission for a material is $5200 A^{\circ}$. Will the photoelectrons be emitted when this material is illuminated with monochromatic radiation from 1 watt ultra violet lamp?

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70. How will the photoelectric current change on decreasing the wavelength of incident radiation for a given photo-sensitive material?

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71. The stopping potential in an experiment on a photo electric effect is 1.5 V. What is the maximum kinetic energy of the photoelectrons emitted?

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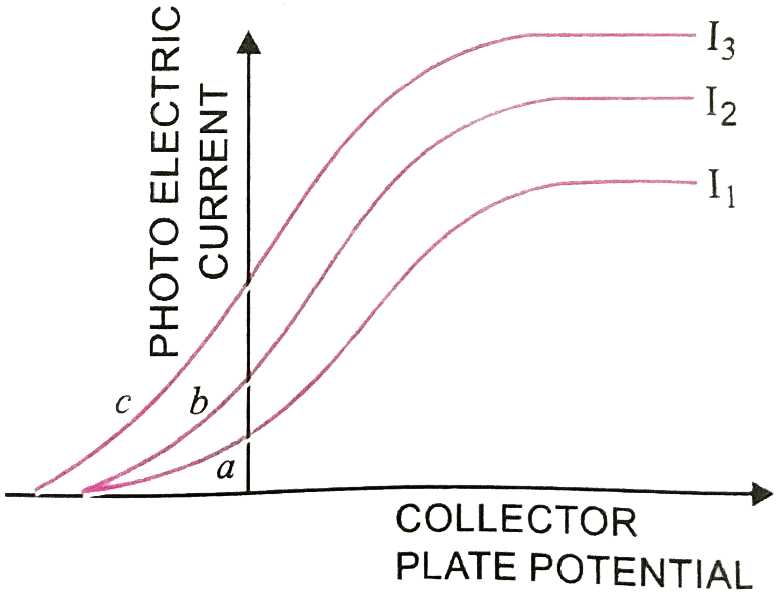
72. The Fig shows a plot of three curves a, b, c showing the variation of photocurrent versis collector plate potential for the different intensities I_1, I_2 and I_3 having frequencies v_1, v_2 and v_3 respectively, incident on a photosensitive surface. Point out the two curves for which the incident radiation have same frequency but different intensities.



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73. Why are alkali metal surfaces most suited as photo-sensitive surfaces?

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74. Does each incident photon essentially ejcted photoelectron?

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75. A source of light is placed at a distance of 1m. From a photocell and the cut off potential is found to be V_0. If the distance is doubled what will be the cut off potential?

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76. Define photoelectric work function. How is it related to thresold frequency?

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77. The work function of cesium is 2eV. Explain this statement.

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78. The work function of lithium and copper are 2.3 eV and 4.0 eV respectively. Which of these metals will be useful for the photo-electric cell working with visible light? Explain.

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79. It is harder to remove free electron from copper than from sodium. Which has higher work function?

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80. The work function of copper is 4.0 eV. If two photons, each of energy 2.5 eV strike with some electrons of copper, will the emission be possible?

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81. What determines the maximum velocity of the photoelectrons?

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82. Define thresold frequency. Is it a constant quantity for a metal surface? Comment. Define space charge. What is its effect on the emission of photoelectrons from a metal surface?

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83. Define space charge. What is its effect on the emission of photoelectrons from a metal surface?

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84. Is photoelectric emission possible at all frequencies? Give reason for your answer?

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85. Out of microwaves, ultraviolet rays and infra-red rays, which radiations will be most effective for emission of electrons from metallic surface?

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86. Two metals A and B have work functions 4 eV and 10 eV respectively. Which metal has higher threshold wavelength?

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87. Does the stopping potential in photoelectric emission depend upon the intensity of the incident radiation in a photo cell? Comment on it.

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88. What is the effect of decrease in frequency of incident radiation on the stopping potential in photoelectric emission?

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89. When the frequency of incident radiation is less than threshold frequency for a metal surface, what is value of stopping potential for that and why?

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90. Two beams one of red light and other of blue light of the same intensity are incident on a metallic surface to emit photoelectrons. Which one of the two beam emits electrons of greater kinetic energy?

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91. The photo electric current at distances $r_1 \text{ and } r_2$ of light source from photoelectric cell are $I_1 \text{ and } I_2$ respectively. Find the value of I_1 / I_2.

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92. Light of frequency .25 v_0 is incident on a metal surface of threshold frequency $2v_0$. If its frequency is halved and intensity is made three times then find the new value of photoelectric current.

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93. How does the maximum kinetic energy of electrons emitted very with work uniform of the metal?

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94. The frequency (v) of the incident radiation is greater than threshold frequency v_0 in photocell. How will the stopping potential very if frequency v is increased, keeping other factors constant.

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95. If the intensity of the incident radiation in a photocell is increased, how does the stopping potential very?

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96. Plot a graph showing the variation of photoelectric current with anode potential for two light beam of same wavelength but different intensity.

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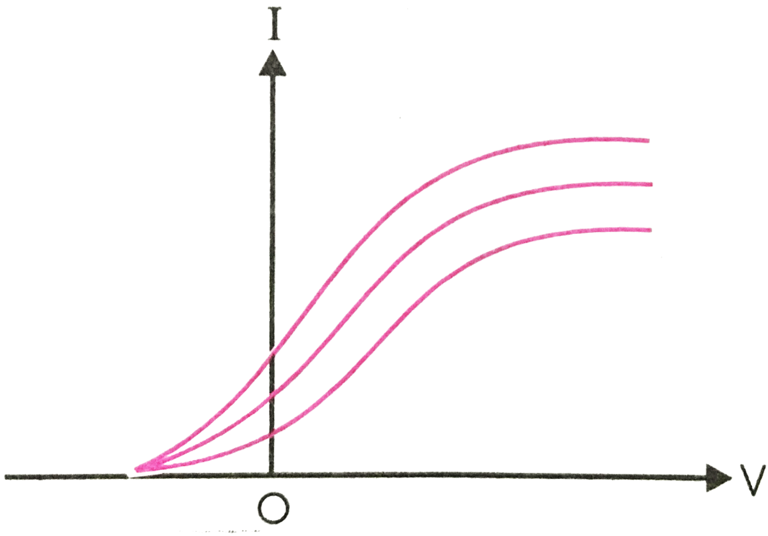
97. In an experiment on photoelectic effect, the graph as shown in fig. were obtained between the photoelectric current (I) and the anode potential (V). Name the characterstic of the incident radiation that was kept constant in this experiment.



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98. Draw a plot showing the variation of photoelectric current versus the intensity of incident radiation on a given photosenstive surface.

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99. Name the phenomenon which shows the quantum nature of electromagnetic radiation.

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100. How does one explain the emission of electrons from a photosenstive surface with the help of Einstein's equation?

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101. If h is Plank's constant. Find the momentum of a photon of wavelength 0.01Å.

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102. What is the energy of a photon in eV corresponding to the vissible light of maximum wavelength?

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103. What is the momentum of photon of energy 3MeV in kg ms^{-1}?

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104. Which photon is more energetic: A red one or a violet one?

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105. Do all the photons of differents colour have the same mass? If not, why?

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106. What consideration led de-Broglie to suggest that material particles can also show wave property?

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107. Why are de-Broglie waves with a moving foot ball not visible?

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108. If an electron behaves like a wave, what should determine the wavelength and frequency of this wave.

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109. Is there any difference between light waves and matter waves?

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110. Are matter waves electronmagnetic? Write de-Broglie equation.

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111. What is the momentum of electron beam of wavelength 4Å? $(h = 6.62 \times 10^{-34} Js)$

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112. What is de-Broglie wavelength of an atom of mass m, moving at absolute temperature TK.

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113. What inference was drawn from Davisson and Germer experiment regarding the nature of electron?

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114. The most proable kinetic energy of thermal neutrons at a temperature of T Kelvin, may be taken equal to kT, where k is Boltzmann constant. Taking the mass of a neutron and its associated de-Broglie wavelength as m and λ_B respectively, state the dependence of λ_B on m and t.

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115. The deBroglie wavelength of a particle of kinetic energy K is λ. What would be the wavelength of the particle, if its kinetic energy were $\frac{K}{4}$?

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116. Find the ratio of de Broglie wavelength of molecules of hydrogen and helium which are at temperatures 27° and $127^\circ C$, respectively.

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117. Name the expriment used to establish the wave nature of electron (i) for slow moving electrons (ii) for fast moving electrons.

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118. In Davisson-Germer experiment, if the angle of diffraction is 52°, the find the glancing angle.

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119. de-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be its wavelength when the accelerating potential is increased to 4V?

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120. Show graphically, the variation of the de-Broglie wavelength (λ) with the potential (V) through which an electron is accelerated from rest.

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121. Draw a plot showing the variation of de-Broglie wavelength of electron as a function of its K.E.

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122. A proton and an electron have same velocity. Which one has greater de-Broglie wavelength and why?

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123. On what principal is an electron micro-scope based?

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124. Is the de-Broglie wavelength of a photon of an electromagnetic radiation equal to the wavelength of the radiation?

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125. Number of ejected photoelectorns increases with an increase in intensity of light but not with the increase in frequency of light. Why?

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126. An increase in the frequency of the incident light increase the velocity with which photoelectron is ejected. Explain how?

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127. Explain the term stopping potential and threshold frequency.

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128. Draw a graph showing the variation of stopping potential with frequency of the incident on a metal plate. How can the value of Planck's constant be determined from this graph?

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129. Radiations of frequencies v_2 and v_2 are made to fall in turn, on a photosenstive surface. The stopping potential required for stopping the most energetic photoelectrons in the two cases are V_1 and V_2 respectively. Obtain a formula for determining the threshold freqeuncy in terms of these parameters.

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130. Using Einstein's photoelectric equation show how the cut -off voltage and threshold frequency for a given photosenstive material can be determined with the help of a suitable plot/graph.

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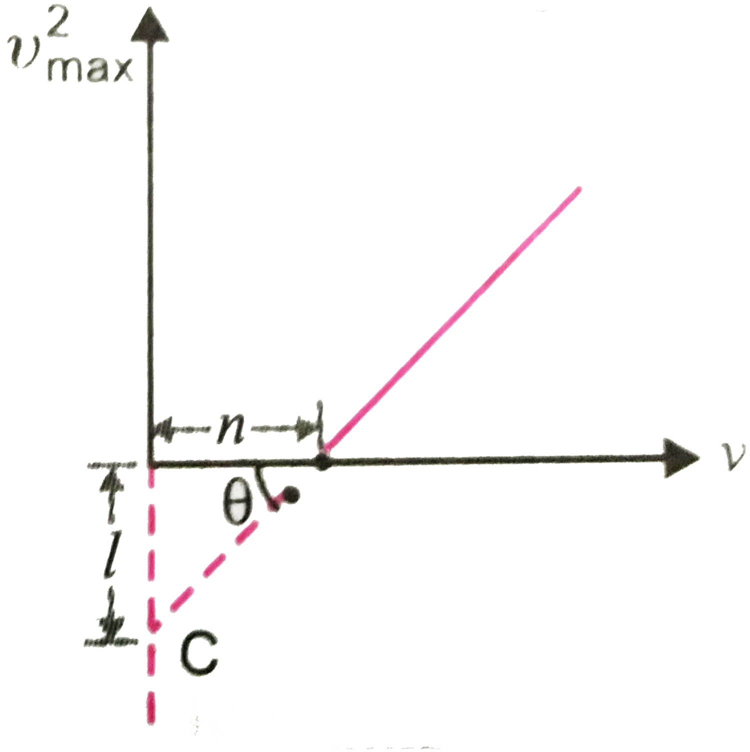
131. When a given photosenstive material is irradiated with light of frequency v, and maximum speed of the emitted photoelectrons equals

$v_{\max}$. The square of $v_{\max}$ is observed to very with v, as per the graph shown in fig. Obtain expression for (i) Planck's constant and (ii) the work function of the given photosenstive material, in terms of the parameter l, n and the mass m of the electrons.



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132. What is the effect on the maximum velocity of the emitted electron if the wavelength of the incident light is decreased?

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133. For a photosenstive surface, threshold wavelength is λ_0. Does photoemission occur if the wavelength (λ) of the incident radiation is (i) more than λ_0 (ii) less than λ_0? Justify your answer.

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134. If we go on increasing the wavelength of light incident on a metal surface, what change in the number of electrons and the energy take place?

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135. The work function for a certain metal is 4.2eV. Will this metal give photoelectric emission for incident radiation of wavelength 330 nm? Use, $h = 6.6 \times 10^{-34} Js$.

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136. Is photoelectric emission possible at all frequencies? Give reason for your answer?

Watch Video Solution

137. State how in a photo-cell, the work function of the metal influence the kinetic energy of the emitted electrons.

(a) If the intensity of the incident radiation is doubled, what change occur in (i) the stopping potential and (ii) in photoelectric current?

(b) If the frequency of the incident radiation is doubled, what changes occur in the (i) stopping potential and (ii) photoelectric current.

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138. Write two characterstic features observed in photoelectric effect which support the photon picture of electromagnetic radiation.

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139. The threshold frequency of a metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5f_0$, the maximum velocity of electrons emitted is v_2. Find the ratio of v_1 and v_2.

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140. Explain how Einstein's photoelectric equation enables us to understand the (i) linear dependence, of the maximum K.E. of the emitted electrons, on the frequency of the incident radiations (ii) existance of a threshold frequency for a given photoemitter.

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141. Green light ejects photoelectrons from a given photosenstive surface where as yellow light does not. What will happen in case of violet and red light? Give reason for your answer.

Watch Video Solution

142. Ultraviolet light is incident on two photosenstive materials having work functions ϕ_1 and $\phi_2 (\phi_1 > \phi_2)$. In which case will the K.E. of the emitted electrons be greater ? Why ?

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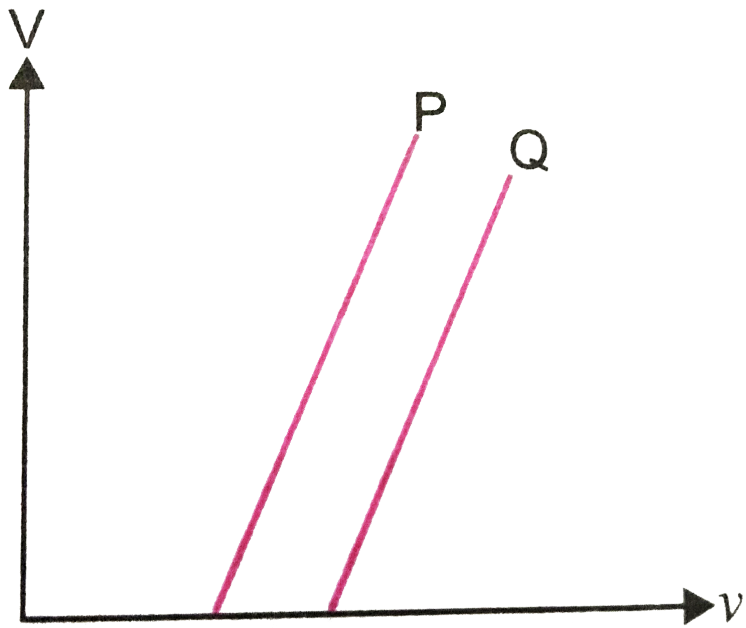
143. In a photoelectric effect experiment, the graph between the stopping potential (V) and frequency (v) of the incident radiations on two different metal plates P and Q are shown in plates, P and Q has greater value of work function ? (ii) What does the slope of the lines depict?



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144. Name the device that converts changes in intesity illumination into changes in electric current. Give three applications of this device.

Watch Video Solution

145. Why is a photoelectric cell also called an electric eye?

Watch Video Solution

146. What is a photon? Show that it has zero rest mass or photons can not exist at rest. Explain.

Watch Video Solution

147. If the wavelength of an electromagentic radiation is doubled, what will happen to (i) the energy of photons and (ii) the momentum of photon?

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148. State two laws of photoelectic emission. Are cathode rays waves or particle?

Watch Video Solution

149. Why is the wave nature of matter not more apparent to our daily observations?

Watch Video Solution

150. A particle of a mass M at rest decays into two particles of masses m_1 and m_2 having non-zero velocities. What is the ratio of the de-Broglie wavelength of the two particles?

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151. Calculate the ratio of the accelerating potential required to accelerate (i) a proton and (ii) and α particle to have the same de-Broglie wavelength associated with them.

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152. An electron, an α-particle and a proton have the same kinetic energy. Which of these particles has the largest de-Broglie wavelength?

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153. A photon and an elecron have the same de Broglie wavelength. Which has greater total energy? Explain

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

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155. Calculate the ratio of de-Broglie wavelengths associated with a deutron moving with velocity 2v and an alpha particle moving with velocity v.

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156. A proton and alpha particle are acclerated through the same accelerating potential. Which one of the two has (a) greater value of de-broglie wavelength associated with it, and (b) less kinetic energy? justify your answer.

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157. An electron and a proton are accelerated through the same potential. Which one of the two has (i)b greater value of de-Broglie wavelength associated with it and (ii) less momentum?justify your answer.

Watch Video Solution

158. A proton and deutron are acclerated through the same accelerating potential. Which one of the two has (a) greater value of de-broglie wavelength associated with it, and (b) less momentum? Give reasons to justify your answer.

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159. An electron and proton have same de-Broglie wavelength. Which one possess greater energy?

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160. An electron and proton have the same de-broglie wavelength. Which one of these has higher kinetic energy? Which one is moving faster?

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161. Plot a graph showing variation of de-broglie wavelength λ versus $1/\sqrt{V}$, where V is accelerating potential for two particle A and P carrying same charge but of masses m_1 and $m_2(m_1 > m_2)$. Which one of the two represents a particle of smaller mass and why?

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162. Describe photoelectric effect and state the laws of photoelectric emission.

Watch Video Solution

163. Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies v_1 and $v_2 (v_1 > v_2)$ of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

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164. Light of intensity I and frequency v is incident on a photosenstive surface and causes photoelectric emission. What will be the effect on anode current when (i) the intensity of light is gradually increased, (ii) the frequency of incident radiation is increased and (iii) the anode potential is increased? In each case, all other factors remains the same. Explain, giving justification in each case.

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165. Write Einstein's photoelectric equation. State clearly any two salient features observe in photoelctric effect, which can be explained on the basis of the above equation.

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166. Derive Einstein's photo-electric relation. Prove intensity law on the basis of Einstein relation.

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167. Find a relation between cut-off potential, frequency of the incident light and threshold frequency.

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168. Write the three characterstic features in photoelectric effect which cannot be explained on the basis of wave theory of light, but can be explained by using Einstein's equation.

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169. Why photoelectric effect cannot be explained on the basis of wave nature of light? Give reasons.

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170. Sketch a graph between frequency of incident radiations and stopping potential for a given photosenstive material. What information can be obtained from the value of the intercept on the potential axis? A source of light of frequency greater than the threshold frequency is placed at a distance of 1m from the cathode of a photocell. The stopping potential is found to be V. If the distance of the light source from the cathode is reduced, explain giving reasons, what change will you observe in the (i) photoelectric current (i) stopping potential?

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171. Sketch the graphs, showing the variation of stopping potential V_s with frequency v of the incident radiations for two photosensitive materials A and B having threshold frequencies $v_0 > v'_0$ respectively.

(i) which of the two metals A or B has higher work function?

(ii) What information do you get from the slope of the graphs?

(iii) What does the value of the intercept of graph A on the potential axis represent?

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172. In a plot of photoelectric current versus anode potential, how does

(i) the saturation current vary with anode potential for incident radiations of different frequencies but same intensity?

(ii) the stopping potential vary for incident radiations of different intensities but the same frequency?

(iii) Photoelectric current vary of different intensities but same frequency of incident radiation? justify your answer is each case.

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173. (i) State two important features of Einstein's photoelectric equation.

(ii) Radiation of frequency $10^{15} Hz$ is incident on two photosenstive surface P and Q. There is no photoemission from surface P. Photoemission occurs from Q but photoelectrons have zero kinetic energy. Explain these observation and find the value of work function for surface Q.

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174. Explain giving reasons for the following :

(a) Photoelectric current in a photocell increases with the increases in intensity of the incident radiation.

(b) The stopping potential (V_0) varries linearly with the frequency (v) of the incident radiation for a given photosenstive surface with the stop remaining the same for different surfaces.

(c) Maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation.

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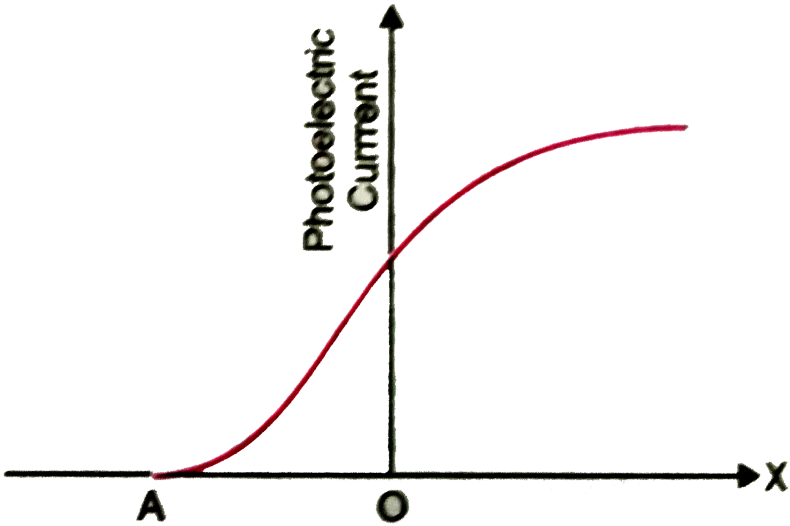
175. The following graph shows the variation of photoelectric current for a photosensitive metal .



(a) Identify the variable X on the horizontal line.

(b) What does the point A on the horizontal axis represent?

(c) Draw this graph for three different values of frequencies of incident radiation v_1, v_2 and $v_3 (v_1 > v_2 > v_3)$ for same intensity.

(d) Draw this graph for three different values of intensities of incident radiation $I_1, I_2, I_3 (I_1 > I_2 > I_3)$ having same frequency.

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176. Using Einstein's photoelectric equation show how the cut -off voltage and threshold frequency for a given photosensitive material can be determined with the help of a suitable plot/graph.

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177. Write the basic features of photon pictures of electromagnetic radiation on which Einstien's photoelectric equation is based.

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178. Explain de Broglie dualistic nature of matter and derive de-Broglie relationship for wavelength of matter waves.

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179. What are matter waves? Show that de-Broglie wavelength associated with an electron of energy, V-electron volt is approx. $\frac{12.27}{\sqrt{V}}\text{Å}$.

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180. What is photoelectric effect? Explain experimentally the variation of photoelectric current with (i) the intensity of the incident light (ii) the potential difference between the plates and (iii) the frequency of the incident light and hence state the laws of photoelectric emission.

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181. State laws of photoelectric emission. Establish Einstein photo-electric relation. Explain the laws of photoelectric emission on the bassis of this relation.

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182. What is photoelectric effect? Give any two practical applications of this effect. Write Einstein's photoelectric equation and use it to explain (i) independence of maximum energy of the emitted photoelectrons from intensity of incident light (ii) existence of a threshold frequency of the emitted photoelectrons from intensity of incident light.

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183. If the wavelength of light incident on a photoelectric cell be reduced from 4000Å to 3600Å, then what will be the change in the cut off potential? $\left(h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C\right)$

Watch Video Solution

184. Light of intensity $10^{-5} Wm^{-2}$ falls on a sodium photocell of surface area $2cm^2$. Assuming that the top 5 layers of sodium absorb the incident energy, estimate the time required for photoelectric emission in the wave picture of radiation. The work function of the metal is givent to be about

2eV. What is the implication of your answer? effective atomic area $= 10^{-20} m^2$.

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185. Estimate the following the following two numbers should be interesting. The first number will tell you why radio engieers do not need to worry much about a photons. The second number tells you why our eye can never "count photon" even in barely detectable light.

(i) The number of photons emitted per second by a MW transmitter of 10kW power emitting radiowaves of length 500m.

(ii) The number of photons entering the pupil of our eye per second corresponding to the minimum intensity of white light that we humans can precieve $(\sim 10^{-10} Wm^{-2})$. Take the area of the pupil to be about $0.4 cm^2$, and the average frequency of white light to be about $6 \times 10^4 Hz$. $(h = 6.6 \times 10^{-34} J)$

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186. In an experiment on photoelectric emission of γ-rays on platinum, the energy distribution of photoelectron exhibits peaks at a number of descrete energies : 270keV, 339keV and 354keV. The binding energy of K,L and M shell in platinum are known to be 77keV, 13keV and 3.5keV approx., what is the wavelength of γ-rays with which the data are consistent.

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187. An X-ray pulse of wavelength 4.9Å is sent through a section of Wilson cloud chamber containing a super saturated gas, and tracks of photoelectrons ejected from the gaseous atom are observed. Two groups of tracks of length 1.40cm and 2.02 cm are noted. If the range-energy relation for cloud chamber is given by $R = \alpha E$, with $\alpha = 1cm / keV$, obtain the binding energies of two levels from which electrons are emitted. Given $h = 6.63 \times 10^{-34} Js$, $e = 1.6 \times 10^{-19} C$.

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188. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential appears which vanishes if a retarding potential greater than 1.2 volt is applied across the phototube. When a different source of light is used, it is found that the critical retarding potential is changed to 2.1 volt. Find the work function of the emitting surface and the wavelength of second source. If the photoelectrons (after emission from the surface) are subjected to a magnetic field of 10 tesla, what changes will be observed in the above two retarding potentials. Use $h = 6.6 \times 10^{-34} Js$, $e = 1.6 \times 10^{-19} C$.

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189. 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.

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190. A monochromatic light soure of frequency f illuminates a metallic surface and ejects photoelectrons. The photoelectrons having maximum energy are just able to ionize the hydrogen atoms in ground state. When the whole experiment is repeated with an incident radiation of frequency $\frac{5}{6}f$, the photoelectrons so emitted are able to excite the hydrogen atom beam which then emits a radiation of wavelength 1215Å. (a) What is the frequency of radiation? (b) Find the work- function of the metal.

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191. A small plate of a metal (work function $= 1.7eV$) is placed at a distance of 2m from a monochromatic light source of wavelength $4.8 \times 10^{-7}m$ and power 1.0watt. The light falls normally on the plate. Find the number of protons striking the metal plate per square metre per second. If a constant magnetic field of strength $10^{-4}T$ is applied parallel to the metal surface, find the radius of the largest circular path followed by the emitted photoelectron. (use $h = 6.63 \times 10^{-34} Js$, mass of electron=$9.1 \times 10^{-31} kg$, charge of electron=$1.6 \times 10^{-19} C$

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192. Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work - function is 2 eV. If a uniform magnetic field of 5×10^{-5} T be applied parallel to the plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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193. A 40 W ultraviolet light source of wavelength $2480 A$. Illuminates a magnesium (mg) surface placed 2 m away. Determine the number of photons emitted from the surface per second and the number incident on unit area of Mg surface per second . The photoelectric work function for Mg is $3.68eV$. Calculate the kinetic energy of the fastest electrons ejected from the surface. Determine the maximum wavelength for which the photoelectric effects can be observed with Mg surface.

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194. A cylindrical rod of some laser material 5×10^{-2}m long and $10^{-2}m$ in diameter contains 2×10^{25} ions per m^3. If on excitation all the ions are in the upper energy level and de-excite simultaneously emitting photons in the same direction , calculate the maximum energy contained in a polse of radiation of wavlength 6.6×10^{-7}m. If the pulse lasts for $10^{-7}s$, calculate the average power of the laser during the pulse.

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195. An X-ray tube operates at 10kV. Find the ratio of X-rays wavelength to that of de-broglie wavelength associated with incident electron.

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196. How fast does a proton have to be moving with order to have the same de-Broglie wavelength as an electron that is moving with a speed of $5.5 \times 10^6 ms^{-1}$? Mass of proton $= 1.67 \times 10^{-27} kg$.

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197. An electron in hydrogen like atom is in excited state 2t has a total energy of -3.4eV. Calculate (a) the kinetic energy (b) the de-Broglie wavelength of the electron. [Given $h = 6.63 \times 10^{-34} Js$]

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198. Find the (a) maximum frequency and (b) minimum wave-length of X-rays produced by 30 kV electrons. Given, $h = 6.63 \times 10^{-34} Js$.

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199. The work function of caesium is 2.14 eV. When light of frequency $6 \times 10^{14} Hz$ is incident on the metal surface, photoemission of electrons occurs. What is the (a) maximum kinetic energy of the emitted electrons. (b) stopping potential and (c) maximum speed of the emitted photoelectrons. given , $h = 6.63 \times 10^{-34} Js, 1eV = 1.6 \times 10^{-19} J, c = 3 \times 10^8 m/s.$

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200. The photoelectric cut off voltage in a certain expriment is 1.5V. What is the maximum kinetic energy of photoelectrons emitted? $e = 1.6 \times 10^{-19} C.$

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201. Monochromatic light of wavelength 632.8nm is produced by a helium-neon laser. The power emitted is 9.42 mW. (a) Find the energy and momentum of each photon in the light beam. (b) How many photons per second, on the average, arrive at a target irradiated by this beam? (Assume the beam to have uniform cross-section which is less than the target area). (c) How fast does a hydrogen atom have to travel in order to have the same momentum as that of the photon. $h = 6.663 \times 10^{-34} Js, 1 a.m.u. = 1.66 \times 10^{-27} kg.$

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202. The energy flux of the sunlight reaching the surface of the earth is $1.388 \times 10^{3} Wm^{-2}$. How many photons (nearly) per square meter are incident on the earth per second? Assume that the photonsin the sunlight have an average wavelength of 550 nm.

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203. In an experiment on photoelectric effect, the slope of the cut off voltage versus frequency of incident light is found to be $4.12 \times 10^{-15} Vs$. Given $e = 1.6 \times 10^{-19} C$, estimate the value of Planck's constant.

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204. A 100W sodium lamp radiates energy uniformly in all directions. The lamp is located at the centre of a large sphere that absorbs all the sodium light which is incident on it. The wavelength of the sodium light is 589nm. (a) What is energy associated per photon with the sodium light? (b) At what rate are photons delivered to the sphere?

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205. The threshold freqeuncy of a certain metal is $3.3 \times 10^{14} Hz$. If light of frequency $8.2 \times 10^{4} Hz$ is incident on the metal, predict the cut off voltage for photoelectric emission. Given Planck's constant, $h = 6.62 \times 10^{-34} Js$.

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206. The work function for a certain metal is 4.2eV. Will this metal give photoelectric emission for incident radiation of wavelength 330nm? Given, charge on electron, $e = 1.6 \times 10^{-19} C, c = 3 \times 10^8 m/s, h = 6.62 \times 10^{-34} Js.$

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207. Light of frequency $7.21 \times 10^{14} Hz$ is incident on a metal surface. Electrons with a maximum speed of $6.0 \times 10^5 ms^{-1}$ are ejected from the surface. What is the threshold frequency for photoemission of electrons? $h = 6.63 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg.$

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208. Light of wavelength 488 nm is produced by an atom laser which is used in the photoelectric effect. When light from this spectral line is incident on the cathode, the stopping potential of photoelectrons is

0.38eV. Find the work function of the material from which the cathode is made. given , $h = 6.63 \times 10^{-34} Js, 1eV = 1.6 \times 10^{-19} J.$

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209. Calculate the (a) momentum and (b) de-Broglie wavelength of the electrons accelerated through a potential difference of 56V. Given, $h = 6.63 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C.$

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210. What is the (a) momentum (b) speed and (c) de-Broglie wavelength of an electron with kinetic energy of 120 eV. Given $h = 6.6 \times 10^{-34} Js, m_e = 9 \times 10^{-31} kg, 1eV = 1.6 \times 10^{-19} J.$

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211. The wavelength of light from the spectral emission line of sodium is 589nm. Find the kinetic energy at which (a) an electron and (b) a neutron would have the same deBroglie wavelength. Given that mass of neutron $= 1.66 \times 10^{-27} kg$

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212. What is the de-Broglie wavelength of (a) a bullet of mass 0.040kg travelling at the speed of $1.0 kms^{-1}$. (b) a ball of mass 0.060 kg moving at a speed of $1.0 ms^{-1}$ and (c) a dust particle of mass $1.0 \times 10^{-9} kg$ drifting with a speed of $2.2 ms^{-1}$? $h = 6.63 \times 10^{-34} Js.$

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213. An electron and a photon each has a wavelength of 1.0nm. Find (a) their momenta, (b) the energy of the photon , and © the kinetic energy electron.

Take $h = 6.63 \times 10^{-34} Js.$

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214. A. For what kinetic energy of neutron will the associated de Broglie wavelength be $1.40 \times 10^{-10} m$?

B. Also, find the de Broglie wavelength of a neutron, in thermal equilibrium with matter, having an average kinetic energy of $\left(\frac{3}{2}\right)$ kT at $300K$. Given the mass of neutron $= 1:66 \times 10^{-27} kg$ and $k = 1.38 \times 10^{-23} Jkg^{-1}$.

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215. Show that the wavelength of electromagnetic radiation is equal to the de-Broglie wavelength of its quantum (photon).

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216. What is the de-Broglie wavelength of nitrogen molecule in air at 300K ? Assume that the molecule is moving with the root mean square speed of molecules at this temperature. (Atomic mass of nitrogen $= 14.0076U$) Plank's constant=$6.63 \times 10^{-34} Js$, Boltzmann constant $= 1.38 \times 10^{-23} JK^{-1}$

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217. (a) Estimate the speed with which electrons emitted from a heated cathode of an evacuated tube impinge on the anode maintained at a potential difference of 500 V with respect to the cathode. Ignore the small initial speeds of the electrons. The specific charge to of the electron, i.e., its e/m is given to $1.76 \times 10^{11} Ckg^{-1}$.

(b) Use the same formula you employ in (a) to obtain electron speed for an anode potential of 10 MV. Do you see what is wrong? In what way is the formula to be modified?

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218. (a) A monoenergetic electron beam with electron speed of $5.20 \times 10^6 ms^{-1}$ is subjected to a magnetic field of $1.30 \times 10^{-4} T$, normal to the beam velocity. What is the radius of the circle traced by the beam, given e/m for electron equal $1.76 \times 10^{11} C. kg^{-1}$.

(b) Is the formula you employ in (a) valid for calculating radius of the path of 20 MeV electrons beam? If not, in what way is it modified!

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219. An electron gun with its anode at a potential of 100V fires out electrons in a spherical bulb containing hydrogen gas at low pressure $(10^{-2} nm of Hg)$. A magnetic field of $2.83 \times 10^{-4} T$ curves the path of the electrons in a circular orbit of radius 12.0 cm. (The path can be viewed becuase the gas ions in the path focus the beam by attracting electrons and emitting light by electron capture, this method is known as 'fine beam tube' method). Determine e/m from the data.

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220. (a) An X-ray tube produces a continuous spectrum of radiation with its shorts wavelength end ate0.45Å. What is the maximum energy of the photon in the radiation? (b) From your answer to (a) , guess what order of accelerating voltage (for electrons) is required in such a tube?

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221. In an accelerator experiment on high energy collision of electrons with positrons, a certain events is interpted as annhilation of an electron-positron pair of total energy 10.2 BeV into two γ-rays of equal energy. What is the wavelength associated with each γ-rays? $\left(1BeV = 10^{9} eV\right)$

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222. Estimate the following the following two numbers should be interesting. The first number will tell you why radio engineers do not need to worry much about a photons. The second number tells you why our eye can never "count photon" even in barely detectable light.

(i) The number of photons emitted per second by a MW transmitter of 10kW power emitting radiowaves of length 500m.

(ii) The number of photons entering the pupil of our eye per second corresponding to the minimum intensity of white light that we humans can perceive $(\sim 10^{-10} Wm^{-2})$. Take the area of the pupil to be about $0.4 cm^2$, and the average frequency of white light to be about $6 \times 10^4 Hz$. $(h = 6.6 \times 10^{-34} J)$

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223. Ultraviolet light of wavelength 2271Å from a 100W mercury souce irradiates a photocell made of molybdenum metal. If the stopping potential is 1.3V, estimate the work function of the metal. How would the photocell respond to a high intensity $(\sim 10^5 Wm^{-2})$ red light of wave length 6328Å produced by a He-Ne laser?

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224. Monochromatic radiation of wave length 640.2 nm $(1nm = 10^{-9}m)$ from a neon lamp irradiates a photosenstive material made of calcium or tungsten. The stopping voltage is measured to be 0.54V. The source is replaced by an iron source and its 427.2 nm line irradiates the same photocell. Predict the new stopping voltage.

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225. A mercury lamp is a convenient souce for studying frequency dependence of photoelectric emission, since it gives a number of spectral lines ranging from the UV to the end of the red vissible spectrum. In our experiment with rubidium photocell, the following lines from a mercury source were used:

$\lambda_1 = 3650A^\circ, \lambda_2 = 4047A^\circ, \lambda_3 = 4358A^\circ, \lambda_4 = 5461A^\circ, \lambda_5 = 6907A^\circ$

The stopping voltages, respectively were measured to be:

$V_{01} = 1.28V, V_{02} = 0.95V, V_{03} = 0.74V, V_{04} = 0.16V, V_{05} = 0V.$

(a) Determine the value of Planck's constant h.

(b) Estimate the threshold frequency and work function for the material.

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226. The work function for the following metals is given Na: 2.75 eV, K:2.30 eV , Mo: 4.17 eV , Ni: 515 eV.

Which of these metals will not give photoelectric emission for a radiation of wavelength 3300 A from a $He - Cd$ laser placed 1m away from the photocell? What happens if the laser is brought nearer and placed 50 cm away?

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227. Light of intensity $10^{-5} Wm^{-2}$ falls on a sodium photocell of surface area $2cm^2$. Assuming that the top 5 layers of sodium absorb the incident energy, estimate the time required for photoelectric emission in the wave picture of radiation. The work function of the metal is given to be about 2eV. What is the implication of your answer? effective atomic area $= 10^{-20} m^2$.

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228. Crystal diffraction experiments can be performed using X-rays, or electrons accelerated through appropriate voltage. Which probe has greter energy? An X-ray photon or the electron? (For quantiative comparision, take the wavelength of the probe equal to 1Å, which is of the order of interatomic spacing in the lattice), $m_e = 9.11 \times 10^{-31} kg$.

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229. (a) Obtain the de-Broglie wavelength of a neutron of kinetic energy 150 eV. As you have seen in previous problem 31, an electron beam of this energy is suitable for crystal differaction experiments. Would a neutron beam of the same energy be equally suitable? Explain. Given $m_n = 1.675 \times 10^{-27} kg$.

(b) Obtain the de-Broglie wavelength associated with thermal neutrons at room temperature $(27^\circ C)$. Hence explain why a fast neutrons beam needs to be thermalised with the environment before it can be used for neutron differaction experiments.

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230. An electron microscope uses electrons accelerated by a voltage of $50kV$. Determine the De Broglie wavelength associated with the electrons. If other factors (such as numerical aperture, etc.) are taken to be roughly the same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light?

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231. The wavelength of a probe is roughly a measure of the size of structure that it can probe in some detail. The quarks structure of photons and neutrons appears at the minute length -scale of $10^{-15}m$ or less. This structure was first probed in early 1970's using high energy electron beam produced by a linear accelerator at Stanford's USA. Guess what might have been the order of energy of these electron beams (Rest mass energy of electron=0.511 eV).

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232. Find the typical de-Broglie wavelength associated with a H-atom in helium gas at room temperature $(27^\circ C)$ and 1atm pressure, and compare it with the mean separation between two atom under these conditions.

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233. Compute the typical de-Broglie wavelength of an electrons in a metal at $27^\circ C$ and compare it with the mean separation between two electrons in a metal which is given to be about $2 \times 10^{-10} m$.

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234. 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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235. (i) In the explanations of photoelectric effect, we assume one photon of frequency v collides with an electron and transfer its energy. This leads to the equation for the maximum energy $E_{\max}$ of the emitted electron as $E_{\max} = hv - \phi_0$ Where ϕ_0 is the work function of the metal. if an electron absorbs 2 photons (each of frequency v) 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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236. 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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237. Do all the electrons that absorb a photon come out as photoelectrons?

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238. 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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239. 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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240. Assuming an electron is confined to a 1nm wide region, find the wavelength in momentum using Heisenberg Uncetainity principal $(\Delta x \Delta p \approx h)$. You can assume the uncertainity in position Δx and 1nm. Assuming $p \cong \Delta p$, find the energy of the electron in electron volts.

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241. 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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242. Two particles A and B of de-broglie wavelength λ_1 and λ_2 combine to from 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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243. A neutron beam of energy E scatters from atoms on a surface with a spacing d=0.1nm. The first maximum of intensity in the reflected beam occures at $\theta = 30^\circ$. What is the kinetic energy of E of the beam in eV?

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244. 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 $\frac{1}{4}\frac{q^2}{4\pi \in_0 d^2}$.

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

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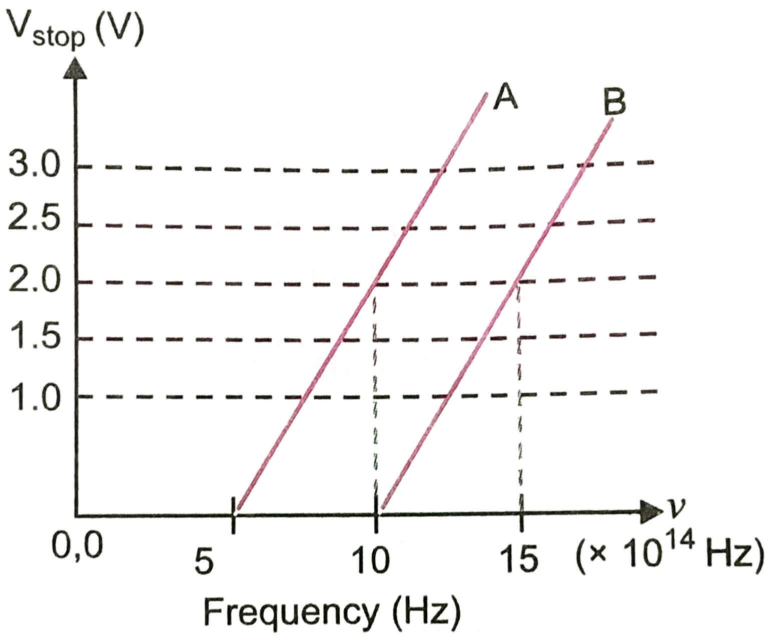
245. A student performs an experiment on photoelectric effect, using two materials A and B. A plot of $V_{s} \top vs. \nu$ is given in fig.

(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 consistant with Eistein's theory.



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

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247. Consider a 20W bult emitting light of wavelength 5000Å and shinning 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 1.5Å.

(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? [Hing : Time calculated in part (iii) is from classical consideration and you may further take the target of surface area say $1 cm^2$ and estimate what would happen?]

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248. A photon and an electron both have energy of 100 eV. Which has greater wavelength? Which has higher linear momentum. $h = 6.63 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C.$

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249. A small metal plate of work function ϕ is kept at a distance r from a singly ionised, fixed ion. A monochromatic light beam is incident on the metal plate and photoelectrons are emitted. Find maximum wavelength of the light beam so that some of that electrons may go round the ion along a circle.

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250. The fringe width in a Young's double slit experiment is 2mm, distance between slit and screen is 1.2 m and separation between the slits is 0.24mm. The radiation of same source is incident on a photo-cathode of work function 2.2eV. Find the stopping potential.

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251. A good quality mirror reflects about 75% of light incident on it. How will you find out, whether 25% of the photons have not been reflected at all or all the photons have been reflected but energy of each has been reduced by 25%?

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252. It is not possible for a photon to be completely absorbed by a free electron. Explain.

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253. A beam of white light is incident normally on a plane surface absorbing 70% of the light and reflecting the rest. If the incident beam of light is power P, find the force exerted by it on the surface.

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Watch Video Solution

254. A beam of white light is incident normally on a plane surface absorbing 70% of the light and reflecting the rest. If the incident beam of light is power P, find the force exerted by it on the surface.

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255. Explain why the saturation current in photoelectric effect experiment with a light of one frequency and intensity is independent of the anode potential.

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256. A 100W light bulb giving monochromatic light of wavelength $6000A^{\circ}$ is placed at the centre of a spherical chamber of radius 0.20m. Assume that 50% of the energy supplied to the bulb is converted into light and that the surface of the chamber is perfectly absorbing. Find (i) the energy and momentum of each photon in the light beam.

(ii) How many photons per second, on the average arrive at the surface of spherical chamber, and

(iii) The pressure exerted by the light on the surface of the chamber. Given, $h = 6.6 \times 10^{-34} Js.$

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257. Find the de-Broglie wavelength (inÅ) associated with an electron moving with a velocity 0.6c, where $c = 3 \times 10^{8} m/s$ and rest mass of electron $= 9.1 \times 10^{-31} kg, h = 6.63 \times 10^{-34} Js.$

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258. Two neutral particles are kept 1m apart. Suppose by some machenism some charge is transferred from one particle to the other and the electric potential energy lost is completely converted into a photon. Calculate the longest and the next smaller wavelength of the photon possible. $h = 6.63 \times 10^{-34} Js.$

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259. Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work - function is 2 eV. If a uniform magnetic field of 5×10^{-5} T be applied parallel to the plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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260. The photons from the Balmer series in Hydrogen spectrum having wavelength between $450nm$ to $700nm$ are incident on a metal surface of work function $2eV$ Find the maximum kinetic energy of ejected electron (Given hc = 1242 eV nm)`

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261. Work function of a metal is the maximum amount of energy required by an electron, to just escape form the metal surface without any kinetic energy. The expression for work function of metal is $\phi_0 = hv_0 = hc/\lambda_0$, where h is Planck's constant, v_0 is the threshold frequency, λ_0 is the threshold wavelength and c is the velocity of light in vacuume. Read the above paragraph and answer the following questions:

(i) Why different metals have different work function?

(ii) What is the threshold wavelength of the incident radiation for a metal surface whose work function is $1.2eV. Given h = 6.63 \times 10^{-34} Js, 1eV = 1.6 \times 10^{-19} J.$

(iii) What do you learn from this study?

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262. Radiation has dual nature, i.e., it possesess the properties of both, wave and particle. This prompted de-Broglie to prodict dual nature of moving material particles. Thus waves are associated with moving material particles which are called matter waves. The wavelength of matter waves is given by $\lambda = \frac{h}{mv}$, where m is the mass, v is the speed of the particle and h is Planck's constant. Read the above paragraph and answer the following question:

(i) How was the wave nature of electron established?

(ii) What are the de-Broglie wavelength associated with a particle (i) at rest (ii) moving with infinite speed?

(iii) What are the basic values displayed by this study?

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263. According to Planck's quantum theory of light, every source of radiation emits photons (i.e., packets of energy) which travel in all directions with the same speed (i.e., speed of light). Each photon is of energy $E = hv = hc/\lambda$, where h is Planck's constant, v is the frequency and λ is wavelength of radiation emitted. The photons emitted from different sources of radiation are different. Read the above passage and answer the following questions:

(i) on what factors does the number of photons emitted per second from a source of radiations depends?

(ii) Why are the high energy photons not vissible to eye?

(iii) Which basic values do you learn from this study?

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264. Photoelectric effect is a phenomenon of emission of electrons from the surfaces of a metal when the light of suitable frequency falls on it. If light of frequency v falls on a photosenstive surface of work function ϕ_0, then the maximum kinetic energy of photoelectron emitted is given by Einstein's photoelectric equation.

$$(KE)_{\max} = \frac{1}{2}mv_{\max}^2 = hv - \phi_0$$

The value $(KE)_{\max}$ will increases if the energy of the incident light (hv) increases of work function (ϕ_0) is decreased. Read above passage and answer the following questions:

(i) Why can visible light not ejected photoelectrons from every surface?

(ii) Light of frequency $7.21 \times 10^{14} Hz$ is incident on a metal surface. Electrons with a maximum speed of $6.0 \times 10^5 ms^{-1}$ are ejected from the surface. What is the threshold frequency for photo emission of electrons?

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

(iii) What do you learn basically from the above study?

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265. Why photographer use red light and not blue light while developing the exposed films?

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266. Many public building have doors that open automatically as people approach. What is the basic concept involved in it?

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Ncert Exerciese Question

1. Answer the following questions:

(a) Quarks inside protons and neutrons are thought to carryfractional charges [(+2/3)e , (–1/3)e]. Why do they not show up in Millikan's oil-drop experiment?

(b) What is so special about the combination e/m? Why do we not simply talk of e and m separately?

(c) Why should gases be insulators at ordinary pressures and start conducting at very low pressures?

(d) Every metal has a definite work function. Why do all photoelectrons not come out with the same energy if incident radiation is monochromatic? Why is there an energy distribution of photoelectrons?

(e) The energy and momentum of an electron are related to the frequency and wavelength of the associated matter wave by the relations:

$E = h\nu, p = \frac{\lambda}{h}$

But while the value of λ is physically significant, the value of ν (and therefore, the value of the phase speed $\nu\lambda$) has no physical significance. Why?

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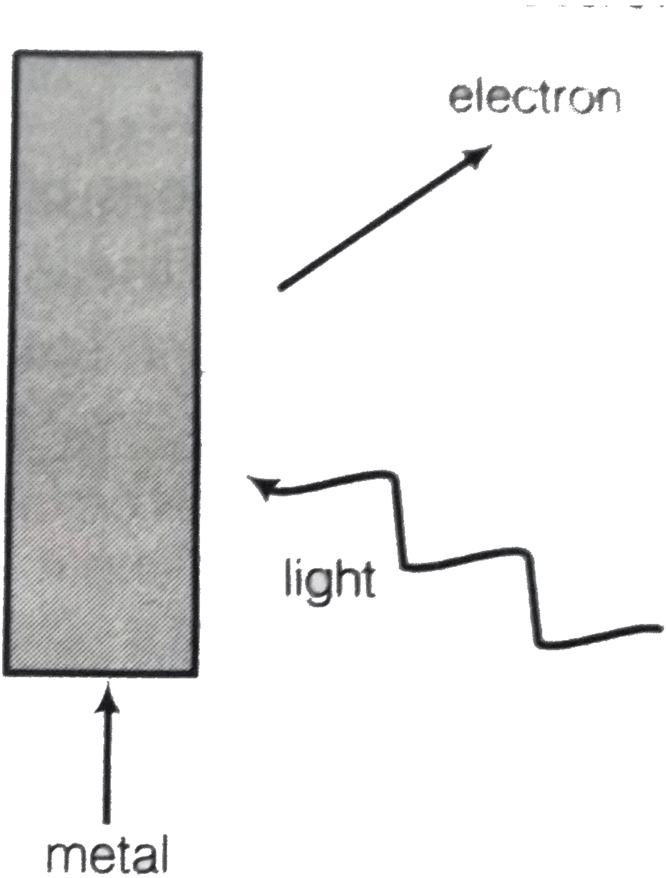
Short Answer

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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Long Answer

1. Consider a thn target $(10^{-2}$ m square, 10^{-3} m thinkness) of sodium, which produces a photocurrent of 100 μA when a light of intensity 100 $W/m^2(\lambda = 660nm)$ falls on it. Find the probability that a photoenectron is produced when a photon strikes a sodium atom.

$$\left[\text{Taken density of Na} = 0.97kg/m^3\right]$$

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Higher Order Thinking Skills

1. Two metallic plates P (collector) and Q (emitter) are separated by a distance of 0.10 meter. These are connected through an ammeter without any cell. A magnetic field B exists parallel to the plates. Light of wavelength between 4000Å and 6000Å fall on the plate whose work function is 2.39eV. Calculate the minimum value of B for which the current registered with ammeter is zero. Use, $h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C$

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Value Based Question

1. "Know your face beauty through complexion meter" was one of the stall on a science exhibition. A student interested to know his/her face beauty was made to stand on a platform and light from a lamp was made to fall on his/her face. The reading of complexion meter indicated the face beauty of the student which might be very fair, fair, semifair, semidark and dark, etc. Read abve passage and answer the following questions:

(i) What is the basic concept used in the working of complexion meter?

(ii) How is the face beauty recorded by face complexion meter?

(iii) What basic values do you learn from the above study?

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Exercise

1. The photoelectric effect can be explained on the basis of

A. Corpuscular theory

B. Wave theory

C. electromagnetic theory

D. quantum theory

Answer: d

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2. Which of the following has minimum stopping potential?

A. Blue

B. Yellow

C. Violet

D. Red

Answer: D

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3. When radiation is incident on a photoelectron emitter, the potential is found to be 9V. If e/m for the electron is $1.810^{11}C/kg$, the maximum velocity of the ejected electron is

A. $6 \times 10^5 m/s$

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

C. $10^6 m/s$

D. $1.8 \times 10^6 m/s$

Answer: d

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4. Two photons, each of energy 2.5 eV are simultaneously incident on the metal surface. If the work function of the metal is 4.5 eV, then from the surface of metal

A. one electron will be emitted with energy 0.5eV

B. two electrons will be emitted with energy 0.25 eV

C. more than two electrons will be emitted

D. not a single electron will be emitted

Answer: d

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5. The maximum velocity of an electron emitted by light of wavelength λ incident on the surface of a metal of work function ϕ, is

Where h = Planck's constant , m = mass of electron and c = speed of light.

A. $\left[\frac{2(hc+\lambda\phi)}{m\lambda}\right]^{1/2}$

B. $\frac{2(hc-\lambda\phi)}{m}$

C. $\left[\frac{2(hc-\lambda\phi)}{m\lambda}\right]^{1/2}$

D. $\left[\frac{2(hc-\phi)}{m}\right]^{1/2}$

Answer: c

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

A. 4125Å

B. 2062.5Å

C. 3000Å

D. 6000Å

Answer: c

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7. The slope of frequency of incident light and stopping potential for a given surface will be

A. h

B. h/e

C. eh

D. e

Answer: b

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8. Threshold wavelength for a metal having work function w_0 is λ. Then the threshold wavelength for a metal having work function $2w_0$ is

A. $4\lambda_0$

B. $2\lambda_0$

C. $\lambda_0/2$

D. $\lambda_0 / 4$

Answer: b

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9. The work function for metals A, B and C are respectively $1.92 eV, 2.0 eV$ and $5 eV$. According to Einstein's equation , the metals which will emit photoelectrons for a radiation of wavelength 4100Å are

A. none

B. A only

C. A and B only

D. B and C only

Answer: c

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10. The wavelength of the matter wave is independent of

A. mass

B. velocity

C. momentum

D. charge

Answer: d

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11. If E_1, E_2, E_3, E_4 are the respective kinetic energies of electron, deutron, proton and neutron having same de-Broglie wavelength. Select the correct order in which those values would increases.

A. E_1, E_3, E_4, E_2

B. E_2, E_4, E_1, E_3

C. E_2, E_4, E_3, E_1

D. E_3, E_1, E_2, E_4

Answer: c

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12. What is de-Broglie wavelength assciated with electron moving under a potential difference of $10^4 V$.

A. $12.27 nm$

B. $1 nm$

C. $0.01227 nm$

D. $0.1227 nm$

Answer: c

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13. The minimum energy required by an electron to..........form the metal surface so as to overcome the restraining forces at the surface is called........... .

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14. The maximum kinetic energy of emitted photoelectrons depends on the..........and nature of............but is independent of........ .

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15. The ratio of number of photoelectrons ejected to the number of the photons falling on a metal surface is..........than.......... .

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16. For given photosenstive material, the photoelectric current is............on decreasing the wavelength of incident radiation, without any change in intensity of radiation.

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17. An increase in the frequency of the incident light............the velocity with which photoelectron is ejected.

Watch Video Solution

18. The minimum energy required to ejected an electron from the surface of a metal is called............ .

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19. In photoelectric effect the energy of the free electron does not depend on.............of light.

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20. Photon is not a..........but it is a.......... .

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21. The velocity of photons different media is............ .

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22. The intensity of light depends upon the.........present in light.

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23. The momentum of a photon of energy E is............and of wavelength λ is............. .

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24. De-Broglie wave are associated with a moving particle irrespective of.............on it.

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25. The de-broglie wavelength of a photon of an electromagnetic radiation is..........the wavelength of the radiation.

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26. A photon and electron have got same de-Broglie wavelength. Total energy of an electron is............than that of photon.

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27. The expression for de-Broglie wavelength of an electron moving under a potential difference of V volt is............. .

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28. The main aim of Davisson-Germer experiment is to verify........... .

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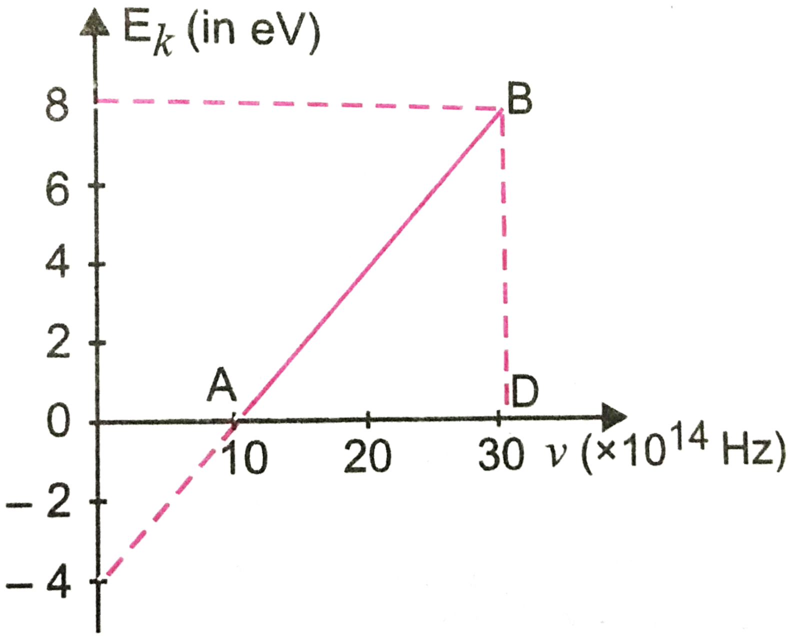
29. Given in fig. is the graph between frequency v of the incident light and maximum kinetiec energy (E_k) of the emitted photoelectrons. Find the values of (i) threshold frequency and (ii) work function form the graph.



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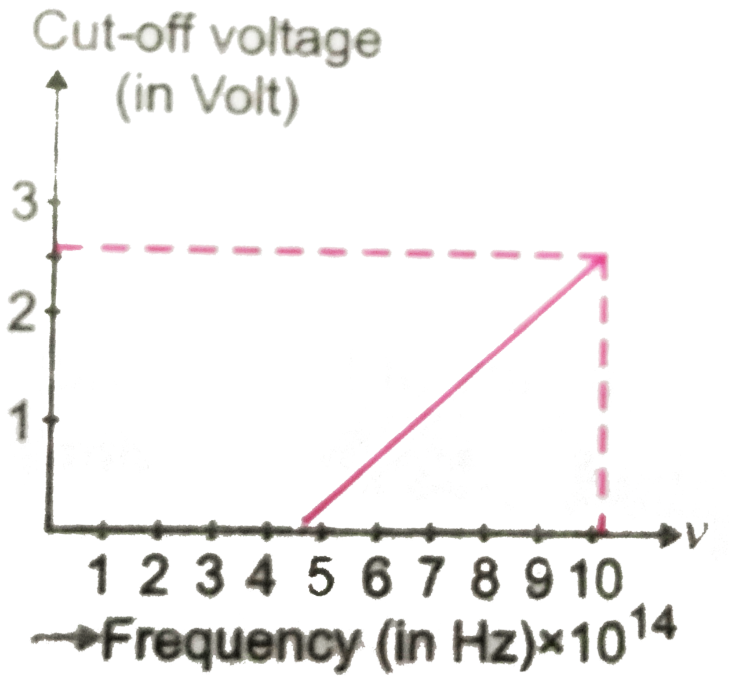
30. For photoelectric effect in sodium, fig. shows the plot of cut-off voltage versus frequency of the incident radiation. Caclculate:



(i) the threshold frequency

(ii) the work function for sodium. (Use $h = 6.6 \times 10^{-34} Js$)

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31. When light of wavelength 400nm is incident on the cathode of photocell, the stopping potential recorded is 6V. If the wavelength of the incident light is to 600nm, calculate the new stopping potential. [Given $h = 6.6 \times 10^{-34} Js, c = 3 \times 10^8 m/s, e = 1.6 \times 10^{-19} C$]

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32. Radiation of a certain wavelength causes electrons with a maximum kinetic energy of 0.65 eV to be ejected from a metal surface whose work function is 2.65 eV. What will be the maximum kinetic energy (in eV) with which this same radiation ejects electrons from another metal whose work function is 2.15eV.

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33. The electric field associated with a monochromataic beam of light becomes zero, 2.4×10^{15} times per second. Find the maximum kinetic energy of the photoelectrons when this light falls on a metal surface whose work function is 2.0eV, $h = 6.63 \times 10^{-34} Js$.

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34. Ultraviolet light of wavelength $800A$ and $700A$ when allowed to fall on hydrogen atoms in their ground states is found to liberate electrons with kinetic energies $1.8eV$ and $4.0eV$, respectively. Find the value of Planck's constant.

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35. Light of wavelength 2000Å falls on an aluminium surface . In aluminium $4.2eV$ of energy is required to remove an electron from its surface. What is the kinetic energy , in electron volt of (a) the fastest and (b) the slowest emitted photo-electron . (c) What is the stopping potential ? (d) What is the cut - off wavelength for aluminum? (Plank's constant $h = 6.6 \times 10^{-34} J - s$ and speed of light `c = 3 xx 10^(8) m s^(-1).

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36. The maximum wavelength for which an em wave can ejected electrons form a platinum surface is 195 nm. When radiations with a wavelength of 131nm shines on the surface. What is the maximum speed of the ejected electrons? [Use $h = 6.63 \times 10^{-34} Js$] $m_e = 9.1 \times 10^{-31} kg$.

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37. Find the frequency of light which ejects electrons from a metal surface. Fully stopped by a retarding potential of $3V$, the photoelectric effect begins in this metal at a frequency of $6 \times 10^{14} Hz$. Find the work function for this metal. (Given $h = 6.63 \times 10^{-34} Js$).

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38. The work fuction of caseium is 1.8 eV. Light of 4500Å is incident on it. Calculate (i) the maximum kinetic energy of the emitted photoelectrons (ii) maximum velocity of the emitted photoelectrons (iii) if the intensity of the incident light is doubled, then find the maximum kinetic energy of the emitted photoelectrons. Given, $h = 6.63 \times 10^{-34} Js. m_e = 9.1 \times 10^{-31} kg, c = 3 \times 10^8 ms^{-1}$

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39. Find the difference of kinetic energies of photoelectrons emitted from a surface by light of wavelength 2500Å and 5000Å. $h = 6.62 \times 10^{-34} Js.$

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40. The electric field associated with a light wave is given by $E = E_0 \sin\left[\left(1.57 \times 10^7 m^{-1}\right)(ct - x)\right]$. Find the stopping potential when this light is used in an experiment on a photoelectric effect with the emitter having work function 2.1eV. $h = 6.62 \times 10^{-34} Js.$

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41. A photon of wavelength 3310Å falls on a photocathode and an electron of energy $3 \times 10^{-19} J$ is ejected. If the wavelength of the incident photon is changed to 5000Å, the energy of the ejected electron is $9.72 \times 10^{-20} J$. Calculate the value of Planck's constant and threhold wavelength of the photon.

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42. Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work - function is 2 eV. If a uniform magnetic field of 5×10^{-5} T be applied parallel to the plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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43. The maximum velcities of the photoelectrons ejected are v and 2v for incident light of wavelength 400nm and 250nm on a metal surface respectively. Calculate the work function of the metal. Given $h = 6.62 \times 10^{-34} Js$ and $c = 3 \times 10^{8} ms^{-1}$

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44. A radio transmitter operates at a frequency of $880kHz$ and a power of $10kW$. The number of photons emitted per second are

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45. The minimum intensity of light to be detected by human eye is $10^{-10} W/m^2$. The number of photons of wavelength $5.6 \times 10^{-7} m$ entering the eye , with pupil area $10^{-6} m^2$, per second for vision will be nearly

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46. Find the number of photons emitted per minute by a 25W source of monochromatic light of wavelength 5000Å. Use $h = 6.63 \times 10^{-34} Js$.

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47. Monochromatic light of frequency $5.0 \times 10^{14} Hz$ is produced by a laser. The power emitted is $3.0 \times 10^{-3} W$. Estimate the number of photons emitted per second on an avearge by the source. Given $h = 6.62 \times 10^{-34} Js$

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48. Caculate the number of photons emitted per second by a 10 watt sodium vepour lamp. Assume tha t 90% of the consumed energy is converted into light. Wavelength of sodium light is 590nm. $h = 6.62 \times 10^{-34} Js$

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49. A parallel beam of the light is incident normally on a plane surface absorbing 40% of the light and reflecting the rest. If the incident beam carries 10 watt power, find the force exerted by it on the surface.

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50. Find the number of photons emitted per second by a 40 W source of monochromatic light of wavelength 6000Å . What is the photoelectric current assuming 5% effeciency of photoelectric effect? Given $h = 6.62 \times 10^{-34} Js$ and $c = 3 \times 10^8 ms^{-1}$, $e = 1.6 \times 10^{-19} C$

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51. An X-ray tube produces a continuous spectrum of radiation with its short wavelength end at 0.42Å. What is the maximum energy of photon in the radiation? What is the order of accelerating voltage (for electrons) requirement in such a case? $h = 6.62 \times 10^{-34} Js$ and $e = 1.6 \times 10^{-19} C$

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52. An electron and a photon each has a wavelength of 1.0nm. Find (a) their momenta, (b) the energy of the photon , and © the kinetic energy electron.

Take $h = 6.63 \times 10^{-34} Js.$

A.

B.

C.

D.

Answer:

$(i) 6.6 \times 10^{-25} kgms^{-1}, 6.6 \times 10^{-25} kgms^{-1} (ii) 1.98 \times 10^{-16} J (iii) 2.39 \times 1$

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53. The de-Broglie wavelength associated with a material particle when it is accelerated through a potential difference of 150V is 1Å. What will be the de-broglie wavelength associated with the same particle when it is accelerted through a potential difference of 1350V?

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54. An electron is accelerated through a potential difference of 64volts. What is the de-broglie wavelength associated with it? To which part of the electromagnetic spectrum does this value of wavelength correspond?

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55. A neutron is an unchanged particle of mass $1.67 \times 10^{-27} kg$. Calculate the de-Broglie wavelength of the neutron moving with a velocity, such that K.E. is 0.04 eV, $h = 6.62 \times 10^{-34} Js$.

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56. Calculate the de-Broglie wavelength of an electron of kinetic energy 100 eV. Given $m_e = 9.1 \times 10^{-31} kg, h = 6.62 \times 10^{-34} Js.$

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57. From a cliff that is 10.0m above a lake, a boy (mass 40 kg) jumps from rest, straight down into the water. At the instant, he strikes the water, what is his de-Broglie wavelength? $\left(g = 10 ms^{-2}\right) h = 6.62 \times 10^{-34} Js$

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58. The de-Broglie wavelength of an electron moving with a velocity $1.5 \times 10^8 ms^{-1}$ is equal to that of a photon. Caculate the ratio of the kinetic energy of the electron to that of photon.

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59. Calculate the energy of an electron having de-Broglie wavelength 5500Å. Given, $h = 6.62 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg.$

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60. An electron and a photon each have a wavelength of 2.00nm. Find (i) their momenta (ii) the energy of the photon and (iii) the kinetic energy of electron. $h = 6.63 \times 10^{-34} Js$

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61. An α-particle and a proton are accelerated from rest through the same potential difference V. Find the ratio of de-Broglie wavelength associated with them.

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62. The wavelength of a photon is 1.4Å. It collides with an electron. Its wavelength after collision is 4Å. Calculate the energy of scattered electron. $h = 6.62 \times 10^{-34} Js$

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63. Find the energy that should be added to an electron of energy 2eV to reduce its de-Broglie wavelength from 1nm to 0.5nm.

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64. The de-broglie wavelength associated with photon changes by 0.25%. If its momentum is changed by $9 \times 10^{-26} kgms^{-1}$, find the initial momentum of electron.

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65. An electron is accelerated through a potential difference of 200volts. What is the de-broglie wavelength associated with it? To which part of the electromagnetic spectrum does this value of wavelength correspond?

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66. Find the de-Broglie wavelength (in Å) assciated with a photon moving with a velocity 0.5 c, where $c = 3 \times 10^8 m/s$, rest mass of proton $= 1.675 \times 10^{-27} kg, h = 6.6 \times 10^{-34} Js.$

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67. Find the de-Broglie wavelength of an electron in a metal at $12.^\circ C$ and compare it with the mean separation between two electrons in a metal which is about $2Å$, Given $h = 6.6 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg.$ Boltzmann constant $k = 1.38 \times 10^{-23} JK^{-1}$

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68. Given that a photon of light of wavelength 10,000Å has an energy equl to 1.23eV. When light of wavelength 5000Å and intensity I_0 falls on a photoelectric cell and the saturation current is 0.40×10^{-6} ampere and the stopping potential is 1.36 volt, then (i)what is the work function? (ii) If intensity of light is made $4I_0$, what should be the saturation current and stopping potential?

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69. The maximum KE of photoelectrons emitted from a cetain metallic surface is 30 eV when monochromatic radiation of wavelength λ falls on it. When the same surface is illuminated with light of wavelength 2λ, the minimum KE of photoelectrons is found to be 10 eV. (a) Calculate the wavelength λ and (b) determine the maximum wavelength of incident radiation for which photoelectric emission is possible.

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70. When a beam of $10.6eV$ photons of intensity $2.0W/m^2$ falls on a platinum surface of area $1.0 \times 10^{-4}m^2$ and work function $5.6eV$, 0.53% of the incident photons eject photoelectrons. Find the number of photoelectrons emitted per second and their minimum and maximum energy (in eV).

Take $1eV = 1.6 \times 10^{-19}J$.

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71. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

if the photoelectrons (after emission form the source) are subjected to a magnetic field of 10 tesla, the two retarding potentials would

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72. What amount of energy (in eV) should be added to an electron to reduce its de-Broglie its de-Broglie wavelength from 100 to 50 pm? Given $h = 6.62 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg.$

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73. A particle is droped from a height H. The de-broglie wavelength of the particle as a funciton of height is proportional to

A. H

B. $H^{1/2}$

C. H^{0}

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

Answer: d

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74. 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. $1.2nm$

B. $1.2 \times 10^{-3} nm$

C. $1.2 \times 10^{-6} nm$

D. $.12 \times 10^{1} nm$

Answer: b

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

A. no electron will be emitted as only photons can emit electrons

B. electrons can be emitted but all with an energy, E_0

C. electron can be emitted with any energy, with a maximum of $E_0 - \phi (\phi$ is the work function)

D. electron can be emitted with any energy, with a maximum of E_0

Answer: d

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76. Consider the fundamental physics for class XII. 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 then that 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: c

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77. 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: b

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78. 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: a

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79. An electron of mass m with an initial velocity $\vec{v} = v_0 \hat{}(i)\ (v_0 > 0)$ enters an electric field $\vec{E} = -E_0 \hat{i}\ (E_0 = cons\tan t > 0)$ at $t = 0$. If λ_0 is its de - Broglie wavelength initially, then its de - Broglie wavelength at time t is

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

B. $\lambda_0\left(1 + \dfrac{eE_0 t}{mv_0}\right)$

C. λ_0

D. $\lambda_0 t$

Answer: a

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

A. λ_0

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

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

D. $\dfrac{\lambda_0}{\sqrt{1+\left(\dfrac{e^2E_0^2t^2}{m^2v_0^2}\right)}}$

Answer: c

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81. Relativistic corrections become necessary when the expresion 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: c,d

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82. 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: a,c

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83. 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: b,c

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84. Photons absorbed in matter are coverted to heat. A source emitting n photons/ sec of frequency v 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 increases n, with v fixed

B. decreases with n fixed, v increases

C. remains constant with n and v changing such that nv= const.

D. increases when the product nv increases

Answer: a,b,c

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85. 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 varries cyclists between two valuse $\lambda_1, \lambda_2 with \lambda_1 > \lambda_2$. 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: b,d

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86. 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. $5\lambda / 2$

D. 3λ

Answer: d

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

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

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

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

Answer: B

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88. If K_1 and K_2 are maximum kinetic energies of photoelectrons emitted when light of wavelength λ_2 and λ_1 respectively are incident on a metallic surface. $If \lambda_1 = 3\lambda_2$ then

A. $K_1 > \left(\frac{K_2}{3}\right)$

B. $K_1 < \left(\frac{K_2}{3}\right)$

C. $K_1 = 3K_2$

D. $K_2 = 3K_1$

Answer: b

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89. The photoelectric threshold wavelength of silver is $3250 \times 10^{-10} m$. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength $2536 \times 10^{-10} m$ is

$(Given h = 4.14 \times 10^{6} ms^{-1} eVs$ and $c = 3 \times 10^{8} ms^{-1})$

A. $\approx 6 \times 10^{5} ms^{-1}$

B. $\approx 0.6 \times 10^{8} ms^{-1}$

C. $\approx 61 \times 10^{3} ms^{-1}$

D. $\approx 0.3 \times 10^{6} ms^{-1}$

Answer: d

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90. A and B are two metals with threshold frequencies $1.8 \times 10^{14} Hz$ and $2.2 \times 10^{14} Hz$. Two identical photons of energy of 0.825 eV each are incident on them. Then photoelectrons are emitted in take $h = 6.6 \times 10^{-34} j/s$

A. B alone

B. A alone

C. neither A nor B

D. Both A and B

Answer: b

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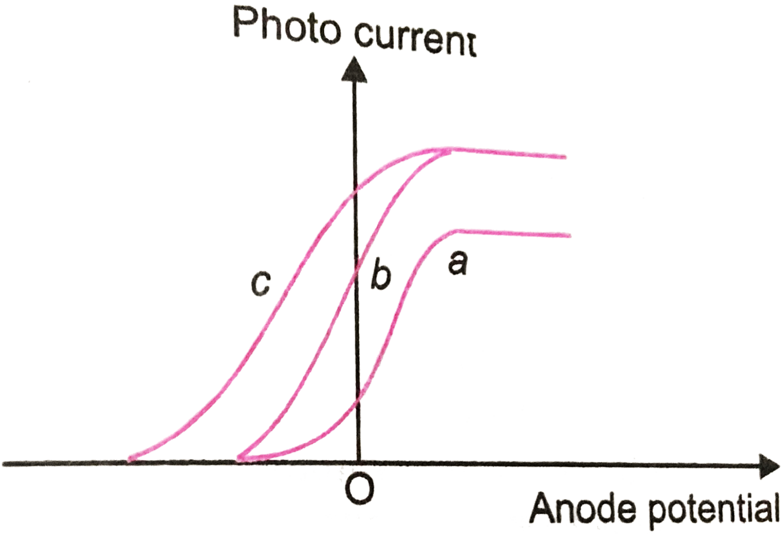
91. The fig. shows the variation of photon current with anode potential for a photo-sensitive surface for three different radiation. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequency for the curves a,b and c respectively.



A. $f_a = f_b$ and $I_a \neq I_b$

B. $f_a = f_c$ and $I_a = I_c$

C. $f_a = f_b$ and $I_a = I_b$

D. $f_b = f_c$ and $I_b = I_c$

Answer: a

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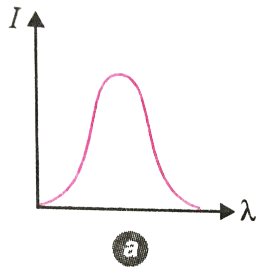
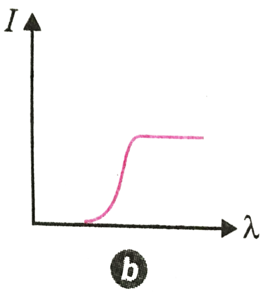
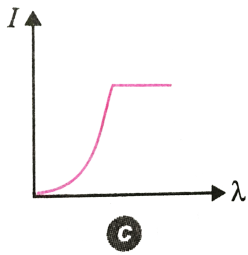
92. The anode vollage of a photocell is kept fixed . The wavelength $\lambda$of the light falling on the cathode varies as follows

A. 

B. 

C. 

D.

Answer: d

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93. In a photoemissive cell, with exciting wavelength λ, the faster electron has speed v. If the exciting wavelength is changed to $3\lambda/4$, the speed of the fastest electron will be

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

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

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

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

Answer: d

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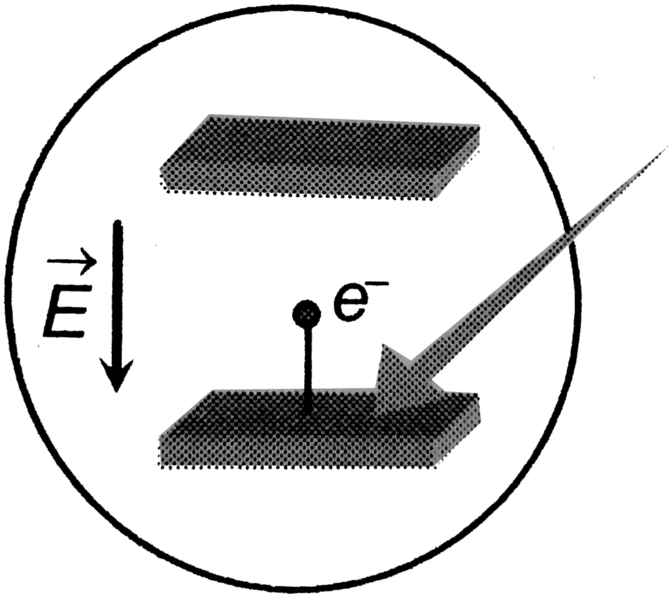
94. The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate . Light source is put on and a saturation photo current is recorded . An electric field is switched on which has a vertically downward direction . Then



A. the stopping potential will decreases

B. the threshold wavelength will increase

C. the photoelectric current will increases

D. the kinetic energy of the current will increases

Answer: d

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95. 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 photoelectric effect is

A. $4\lambda / 3$

B. 4λ

C. 6λ

D. 8λ

Answer: b

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96. The kinetic energy of an electron is E when the incident wavelength is λ To increase ti KE of the electron to 2E, the incident wavelength must be

A. $\frac{hc}{E\lambda - hc}$

B. $\frac{h\lambda}{E\lambda + hc}$

C. $\frac{hc\lambda}{E\lambda + hc}$

D. $\frac{hc\lambda}{E\lambda - hc}$

Answer: c

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97. When light of wavelength 400nm is incident on the cathode of photocell, the stopping potential recorded is 6V. If the wavelength of the incident light is to 600nm, calculate the new stopping potential. [Given $h = 6.6 \times 10^{-34} Js, c = 3 \times 10^{8} m/s, e = 1.6 \times 10^{-19} C$]

A. $4.97V$

B. $4.76V$

C. $4.56V$

D. $4.14V$

Answer: d

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98. A photosenstive metallic surface has work function hv_0. If photons of energy $3hv_0$ falls on this surface. The electrons come out with a maximum velocity of $5 \times 10^6 m/s$. When the photon energy is increased to $9hv_0$. The maximum velocity of photoelectrons will be:

A. $10^7 m/s$

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

C. $10^9 m/s$

D. $10^8 m/s$

Answer: a

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99. Maximum velocity of photoelectrons emitted by a metal surface is $1.2 \times 10^6 m/s$. Assuming the specific charge of the electrons to be $1.8 \times 10^{11} C/kg$ the value of stopping potential in volt will be:

A. 2

B. 3

C. 4

D. 6

Answer: c

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100. If the frequency of light in a photoelectric experiment is doubled the stopping potential will

A. be doubled

B. be halved

C. become more than double

D. becomes less than double

Answer: c

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101. The velocity of the most energetic electrons emitted from a metallic surface is doubled when the frequecy v of incident radiation is double. The work function of this metal is

A. Zero

B. $hv/3$

C. $hv/2$

D. $2hv/3$

Answer: d

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102. Light of wavelength λ strikes a photo - sensitive surface and electrons are ejected with kinetic energy is to be increased to $2E$, the wavelength must be changed to λ' where

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

B. $\lambda' = 2\lambda$

C. $\lambda' < \lambda$

D. $\frac{\lambda}{2} < \lambda' < \lambda$

Answer: d

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103. Two identical metal plates show photoelectric effect by a light of wavelength λ_A falls on plate A and λ_B on plate $B(\lambda_A = 2\lambda_B)$. The maximum kinetic energy is

A. $2K_A = K_B$

B. $K_A < K_B/2$

C. $K_A = 2K_B$

D. $K_A = K_B/2$

Answer: b

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104. A metal is illumimated by light of two different wavelength $248nm$ and $310nm$. The maximum speeds of the photoelectrons corresponding in these wavelength are u_1 and u_2 respectively . If the ratio $u_1 : u_2 = 2 : 1$ and $hc = 1240eVnm$, the work function of the meal is nearly

A. $3.7eV$

B. $3.2eV$

C. $2.8eV$

D. $2.5eV$

Answer: a

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105. Monochromatic light of frequency f_1 incident on a photocell and the stopping potential is found to be V_1. What is the new stopping potential of the cell if it is radiated by monochromatic light of frequency f_2?

A. $V_1 - \frac{h}{e}(f_2 - f_1)$

B. $V_1 + \frac{h}{e}(f_2 + f_1)$

C. $V_1 - \frac{h}{e}(f_2 + f_1)$

D. $V_1 + \frac{h}{e}(f_2 - f_1)$

Answer: d

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106. A metal plate is exposed to light with wavelength λ. It is observed that electrons are ejected from the surface of the metal plate. When a retarding uniform electric field E is imposed, no electron can move away from the plate farther than a certain distance d. Then the threshold wavelength λ_0 for the material of plate is (e is the electronic charge, h is Planck's constant and c is the speed of light)

A. $\frac{\lambda eEd}{(eEd - hc)}$

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

C. $\frac{eEd\lambda - hc}{hc\lambda}$

D. $\frac{\lambda hc - eEd}{hc\lambda}$

Answer: b

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107. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light. If the maximum value of kinetic energies of the photoelectrons emitted in the two cases are in the ratio $n : 1$ then the threshold frequency of the metallic surface is

A. $\dfrac{v_2 - v_1}{n - 1}$

B. $\dfrac{nv_2 - v_1}{n - 1}$

C. $\dfrac{nv_1 - v_2}{n - 1}$

D. $\dfrac{v_2 - v_1}{n}$

Answer: b

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108. The threshold frequency for certain metal is v_0. When light of frequency $2v_0$ is incident on it, the maximum velocity of photoelectrons is $4 \times 10^6 ms^{-1}$. If the frequency of incident radiation is increaed to $5v_0$, then the maximum velocity of photoelectrons will be

A. $(4/5) \times 10^6$

B. 2×10^6

C. 4×10^6

D. 8×10^6

Answer: d

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109. Silver has a work function of 4.7 eV. When ultraviolet light of wavelength 100 nm is incident upon it, a potential of 7.7 V is required to stop the photo electrons from reaching the collector plate. How much potential will be required to stop the photoelectrons when light of wavelength 200nm is incident upon silver?

A. $3.85V$

B. $1.93V$

C. $1.50V$

D. $3.0V$

Answer: c

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110. In a photoelectric effect experiment, the maximum kinetic energy of the emitted electrons is 1eV for incoming radiations of frequency v_0 and 3eV for incoming radiation of frequency $3v_0/2$. What is the maximum kinetic energy of the electrons emitted for incomming radiation of frequency $9v_0/4$?

A. $3eV$

B. $4.5eV$

C. $6eV$

D. $9eV$

Answer: c

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111. The work function of a surface of a photosensitive material is $6.2eV$. The wavelength of the incident radiation for which the stopping potential is $5V$ lies in the

A. infrared region

B. X-ray region

C. ultraviolet region

D. visible region

Answer: c

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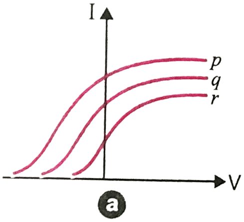
112. Photoelectric effect experiments are performed using three different metal plates p, q and r having work function $\phi_p = 2.0eV, \phi_e = 2.5eV$ and $\phi_r = 3.0eV$ respectively A light beam containing wavelength of $550nm, 450nm$ and $350nm$ with equal intensities illuminates each of the plates . The correct $I - V$ graph for the experiment is [Take hc = 1240 eV nm]

A.



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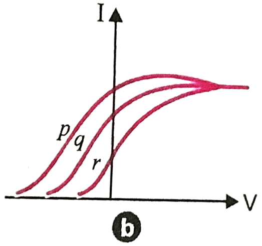

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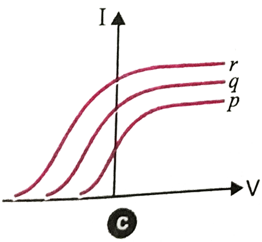

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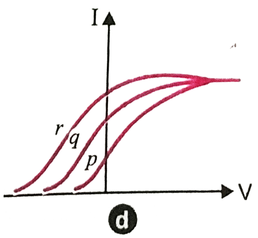

Answer: A

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113. Given that a photon of light of wavelength 10,000Å has an energy equal to 1.23eV. When light of wavelength 5000Å and intensity I_0 falls on a photoelectric cell and the saturation current is 0.40×10^{-6} ampere and the stopping potential is 1.36 volt, then (i)what is the work function? (ii) If intensity of light is made $4I_0$, what should be the saturation current and stopping potential?

A. $0.43eV$

B. $1.10eV$

C. $1.36eV$

D. $2.72eV$

Answer: b

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114. When the energy of the incident radiation is increased by 20% , kinetic energy of the photoelectrons emitted from a metal surface increased from $0.5eV \rightarrow 0.8eV$. The work function of the metal is

A. $0.65eV$

B. $1.0eV$

C. $1.3eV$

D. $1.5eV$

Answer: b

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115. Light described at a place by the equation $E=(100V/m)\left[\sin\left(6\times10^{15}s^{-1}\right)t+\sin\left(8\times10^{15}s^{-1}\right)t\right]$ falls on a metal surface having work fuction 2.28 eV. The maximum energy of the photoelectrons is : (use $h=6.63\times10^{-34}Js$)

A. $2.28eV$

B. $3.0eV$

C. $1.24eV$

D. $1.50eV$

Answer: b

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116. The curve drawn between velocity and frequency of a photon in vacuum will be

A. straight line parallel to frequency axis

B. straight line parallel to velocity axis

C. straight line passing through origin and making an angle of 45° with frequency axis

D. hyperbola

Answer: a

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117. The momentum of a photon of an electromagnetic radiation is $4.3 \times 10^{-29} Kgm/s$. What is the frequency of the associated wave? $\left[h = 6.6 \times 10^{-34} Js, c = 3 \times 10^8 m/s\right]$

A. $1.5 \times 10^{13} Hz$

B. $1.95 \times 10^{13} Hz$

C. $5.6 \times 10^{13} Hz$

D. $3.9 \times 10^{13} Hz$

Answer: B

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118. Wavelength of a $1keV$ photon is $1.24 \times 10^{-9}m$. What is the frequency of $1MeV$ photon ?

A. $1.24 \times 10^{15} Hz$

B. $2.4 \times 10^{20} Hz$

C. $1.24 \times 10^{18} Hz$

D. $2.4 \times 10^{23} Hz$

Answer: B

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119. Ultraviolet light of wavelength 300nn and intensity $1.0 Wm^{-2}$ falls on the surface of a photosensitive material. If one per cent of the incident photons produce photoelectrons, then the number of photoelectrons emitted per second from an area of 1.0 cm^2 of the surface is nearly

A. 2.13×10^{11}

B. $1.51x10^{12}$

C. 4.12×10^{13}

D. 9.61×10^{14}

Answer: b

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120. We may state that the energy E of a photon of frequency v is E =hv, where h is a plank's constant. The momentum p of a photon is $p = h/\lambda$ where λ is the wavelength of the photon. From the above statement one may conclude that the wave velocity of light is equal to

A. $3 \times 10^8 m/s$

B. E/p

C. Ep

D. $(E/p)^2$

Answer: b

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121. A sodium lamp emits 3.14×10^{20} photons per second. Calculate the distance from sodium lamp where flux of photon is one photons per second per cm^2

A. $10^{10} cm$

B. $5 \times 10^{9} cm$

C. $5 \times 10^{8} cm$

D. $10^{9} cm$

Answer: b

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122. 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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123. One gram mass falls through a height of 2cm. If whole of the energy of fall is converted into light of wavelength $6.63 \times 10^{-7} m$, how many photons would be produced? Given $h = 6.63 \times 10^{-7} Jsg = 10 m / s^2$

A. 3.33×10^{14}

B. 3.33×10^{15}

C. 6.67×10^{14}

D. 6.67×10^{15}

Answer: c

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124. A parallel beam of the light is incident normally on a plane surface absorbing 40% of the light and reflecting the rest. If the incident beam carries 10 watt power, find the force exerted by it on the surface.

A. $1.11 \times 10^{-8} N$

B. $2.22 \times 10^{-8} N$

C. $3.33 \times 10^{-8} N$

D. $6.66 \times 10^{-8} N$

Answer: C

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125. A beam of light of wavelength 400nm and power 1.55 mW is directed at the cathode of a photoelectric cell. If only 10% of the incident photons effectively produce photoelectrons, then find current due to these electrons. (given $hc = 1240eV - nm, e = 1.6 \times 10^{-19} C$)

A. $5\mu A$

B. $40\mu A$

C. $50\mu A$

D. $114\mu A$

Answer: c

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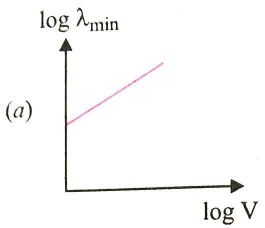
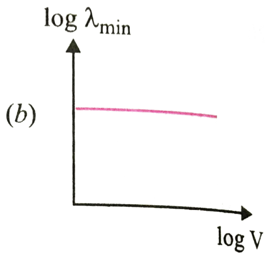
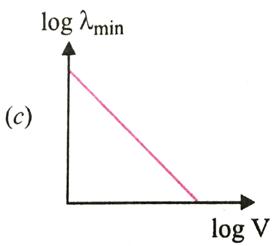
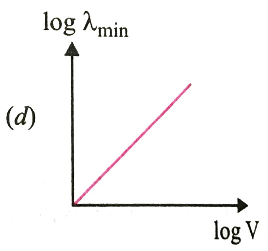
126. An electron beam is acceleration by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If $\lambda_{\min}$ is the smallest possible wavelength of X-rays in the spectrum, the variation of $\log \lambda_{\min}$ with $\log v$ is correctly represented in

A. 

B. 

C. 

D. 

Answer: c

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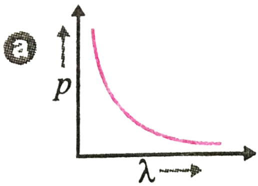
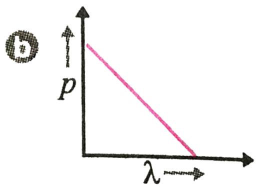
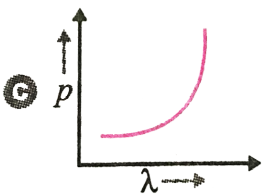
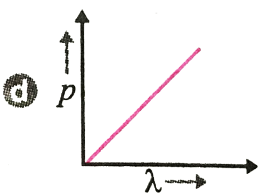
127. Which of the following figure represents the variation of particle momentum and the associated de - Broglie wavelength ?

A. 

B. 

C. 

D. 

Answer: a

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128. An X-ray tube operates at 10kV. Find the ratio of X-rays wavelength to that of de-broglie wavelength associated with incident electron.

A. $10:1$

B. $1:10$

C. $1:100$

D. $100:1$

Answer: a

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129. The de - Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature $T(\text{kelvin})$ and mass m, is

A. $\dfrac{h}{\sqrt{mkT}}$

B. $\dfrac{h}{\sqrt{3mkT}}$

C. $\dfrac{2h}{\sqrt{3mkT}}$

D. $\dfrac{2h}{\sqrt{mkT}}$

Answer: b

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130. If λ_1 and λ_2 denote the wavelength of de-broglie waves for electron in Bohr's first and second orbits in the hydrogen atom, then λ_1 / λ_2 will be

A. 2

B. $1/2$

C. 4

D. $1/4$

Answer: b

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131. The energy that should be added to an electron, to reduce its de-Broglie wavelength from $2 \times 10^{-9}m$ to $0.5 \times 10^{-9}m$ will be:

A. $1.1MeV$

B. $0.56MeV$

C. $0.56KeV$

D. $0.56eV$

Answer: d

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132. The ratio between masses of two particles is $1:2$ and ratio between their temperatures is also $1:2$. The ratio between their de-Broglie wavelengths is:

A. $1:2$

B. $2:1$

C. $1:3$

D. $3:1$

Answer: b

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133. For Bragg's differaction by a crystal to occur, then the X-ray of wavelength λ and ineratomic distance d must be

A. λ is greater than $2d$

B. λ equals $2d$

C. λ is smaller than or equal to $2d$

D. $\lambda$is smaller than $2d$

Answer: c

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134. The de-Broglie wavelength of the tennis ball of mass 60g moving with a velocity of $10m/s$ is approx.: (Plank's constant $h = 6.63 \times 10^{-34} Js$)

A. $10^{-33}m$

B. $10^{-31}m$

C. $10^{-16}m$

D. $10^{-25}m$

Answer: a

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135. The de-Broglie wavelength associated with proton changes by 0.25% if its momentum is changed by p_0. The initial momentum was

A. $100p_0$

B. $p_0/400$

C. $401p_0$

D. $p_0/100$

Answer: c

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136. The de - Broglie wavelength of a particle moving with a velocity $2.25 \times 10^8 m/s$ is equal to the wavelength of photon. The ratio of kinetic energy of the particle to the energy of the photon is (velocity of light is $3 \times 10^8 m/s$

A. $1/8$

B. $3/8$

C. $5/8$

D. $7/8$

Answer: b

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137. The energy of a photon is equal to the kinetic energy of a proton. The energy of the photon is E. Let λ_1 be the de-Broglie wavelength of the proton and λ_2 be the wavelength of the photon. The ratio $\frac{\lambda_1}{\lambda_2}$ is proportional to

(a)E^0 (b) $E^{1/2}$ (c) E^{-1} (d)E^{-2}

A. E^0

B. $E^{1/2}$

C. E^{-1}

D. E^{-2}

Answer: b

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138. 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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139. The ratio of de - Broglie wavelength of α- particle to that of a proton being subjected to the same magnetic field so that the radii of their path are equal to each other assuming the field induction vector $\overrightarrow{B}$ is perpendicular to the velocity vectors of the α - particle and the proton is

A. $1/4$

B. $1/2$

C. 1

D. 2

Answer: b

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140. Find the ratio of de Broglie wavelength of molecules of hydrogen and helium which are at temperatures 27° and $127^{\circ}C$, respectively.

A. $2/\sqrt{3}$

B. $2/3$

C. $\sqrt{3}/8$

D. $\sqrt{3/8}$

Answer: d

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141. What is the de - Broglie wavelength of the alpha - particle accelerated through a potential difference V?

A. $\frac{12.27}{\sqrt{V}}$Å

B. $\frac{0.202}{\sqrt{V}}$Å

C. $\frac{0.101}{\sqrt{V}}$Å

D. $\frac{2.87}{\sqrt{V}}$Å

Answer: c

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142. 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: b

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

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

C. $\lambda/(1-V/E)^2$

D. $\lambda/(1+V/E)^2$

Answer: c

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144. λ_e, λ_p and λ_α are the de-Broglie wavelength of electron, proton and α particle. If all the accelerated by same potential, then

A. $\lambda_e < \lambda_p < \lambda_\alpha$

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

C. $\lambda_e > \lambda_p > \lambda_\alpha$

D. $\lambda_e > \lambda_p < \lambda_\alpha$

Answer: c

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145. The ratio of the de-Broglie wavelengths of an electron of energy 10 eV to that of a person of mass 66kg travelling with a speed of $100km/h$ is of the order of

A. 10^{34}

B. 10^{27}

C. 10^{17}

D. 10^{-10}

Answer: b

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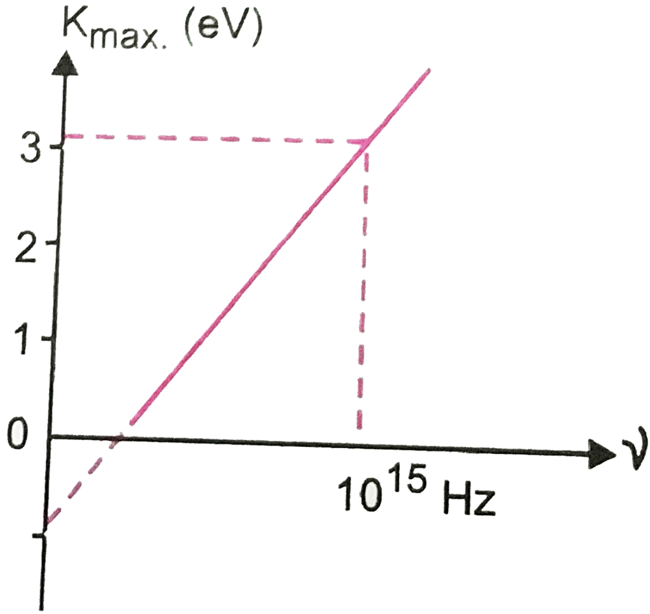
146. represents a graph of most energetic photoelectrons $K_{\max}$(in eV) and frequency v for a metal used as cathod in photoelectrons experiment. The threshold frequency of light for the photoelectric emission from the metal is



A. $1 \times 10^{14} Hz$

B. $1.5 \times 10^{14} Hz$

C. $2.1 \times 10^{14} Hz$

D. $2.7 \times 10^{14} Hz$

Answer: d

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147. Electrons used in an electron microscope are accelerated by a voltage of $25kV$. If the voltage is increased to $100kV$ then the de - Broglie wavelength associated with the electrons would

A. increases by 2 times

B. decreases by 2 times

C. decreases by 4 times

D. increases by 4 times

Answer: b

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148. After absorbing a slowly moving neutrons of mass m_N (momentum ~0) a nucleus of mass M breaks into two nuclie of mass m_1 and $5m_1(6m_1 = M + m_N)$, respectively . If the de-Broglie wavelength of the nucleus with mass $m_1 is \lambda$, then de Broglie wavelength of the other nucleus will be

A. 25λ

B. 5λ

C. $\lambda/5$

D. λ

Answer: d

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149. A α -parhticle moves in a circular path of radius $0.83cm$ in the presence of a magnetic field of $0.25Wb/m^2$. The de-Broglie wavelength assocaiated with the particle will be

A. $1A$

B. $0.1A$

C. $10A$

D. $0.01A$

Answer: d

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150. If the momentum of an electron is changed by p, then the de - Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be

A. $200P$

B. $400P$

C. $\frac{P}{200}$

D. $100P$

Answer: a

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

Answer: a

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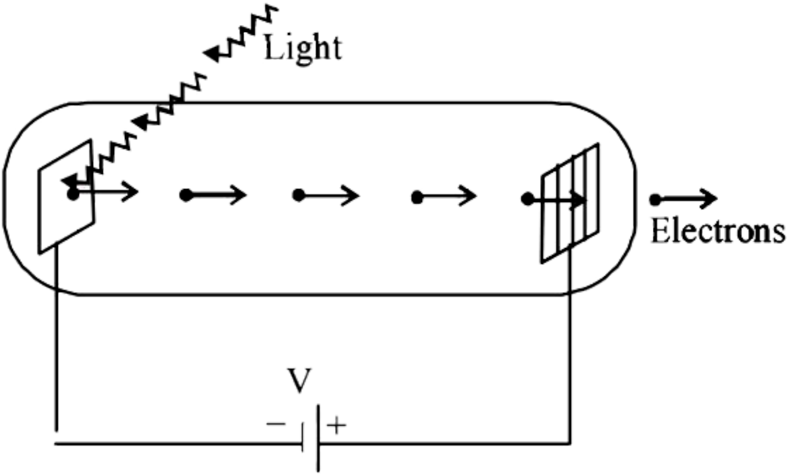
152. Light of wavelength λ_{ph}falls on a cathode plate inside a vacuum tube as shown in the figure .The work function of the cathode surface is ϕ and the anode is a wire mesh of conducting material kept at distance d from the cathode. A potential different V is maintained between the electrodes. If the minimum de Broglie wavelength of the electrons passing through the anode is λ_e which of the following statement (s) is (are) true?



A. For large potential difference $(V > > \phi/e)$, λ_e is approx. halved if V is made four times

B. λ_e decreases with increases in ϕ and λ_{ph}

C. λ_e increases at the same rate as λ_{ph} for $\lambda_{ph} < hc/\phi$

D. λ_e approx. halved if d is doubled

Answer: a

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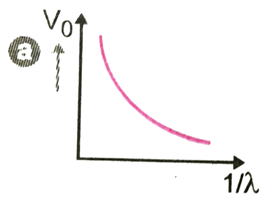
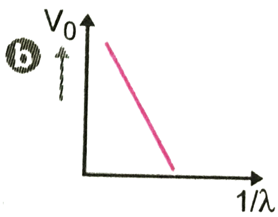
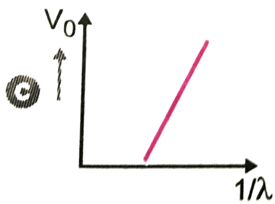
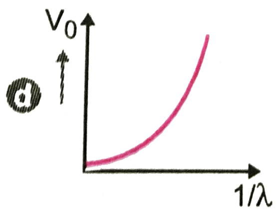
153. For photo - electric effect with incident photon wavelength λ the stopping is V_0 identify the correct variation(s) of V_0 with λ and $1/\lambda$

A. 

B. 

C. 

D. 

Answer: a,c

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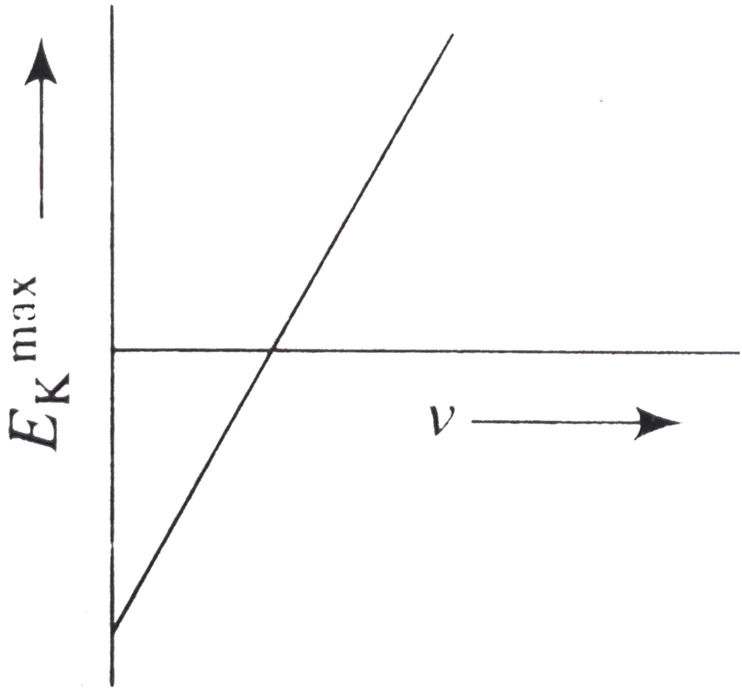

154.

The maximum kinetic energy of the emitted photoelectrons against frequency υ of incident radiation is plotted as shown in Fig. This graph help us in determining the following physical quantities

A. Planck's constant

B. charge of an electron

C. threshold frequency

D. work function of cathode metal

Answer: a,c,d

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155. If the wavelength of light in an experiment on photoelectric effect is doubled,

(i) the photoelectric emission will not take place

(ii) the photoelectric emission may or may not take place

(iii) the stopping potential will increase

(iv) the stopping potential will decrease

A. the photoelectric emission will not take place.

B. the photoelectric constant emission may or may not take place

C. the stopping potential will decreases

D. the stopping potential will increases

Answer: b,c

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156. Choose the incorrect statement:

A. The velocity of photoelectrons is directely proportional to the square root of wavelength of light

B. The number of photoelectrons emitted depeds upon the intensity of incident light

C. The velocity of photoelectron is directely proportional to the frequency of the incident light

D. The velocity of the photoelectrons is inversely proportional to square root of the frequency of the light.

Answer: a,c,d

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157. Photoelectric effect supports quantum nature of light because

A. there is a minimum frequecy of light below which no photoelectrons are emitted

B. the maximum K.E. of photoelectron emitted depends only on the frequency of the incident light and not on its intensity.

C. even when metal surface is faintly illuminated, the photoelectrons leave the surface immediately.

D. electric charge of photoelectron is quantised.

Answer: a,b,c

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158. The maximum K.E. of photoelectrons ejected from a photometer when it is irradiated with radiation of a wavelength 400nm is 1eV. If the threshold energy of the suface is 1.9 eV,

A. the maximum K.E. of photoelectrons when it is irradiated with $500nm$ photons will be $0.42eV$

B. the maximum K.E. of photoelectron when it is viradiated with $500nm$ photons will be $0.43eV$

C. maximum K.E. will increases if the intensity of radiation is increased

D. the longest wavelength which will eject the photoelectrons from the surface is nearly $610nm$

Answer: a,d

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159. An electron and proton have same de-Broglie wavelength. Which one possess greater energy?

A. zero

B. infinity

C. equal to K.E. of proton

D. greater than K.E. of proton

Answer: d

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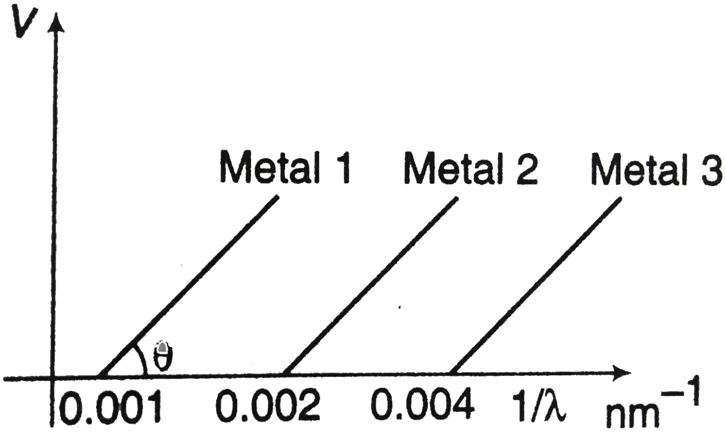
160. The graph between $1/\lambda$ and stopping potential (V) of three metals having work- functions Φ_1, Φ_2 and Φ_3 in an experiment of photoelectric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct? (Here, λ is the wavelength of the incident ray). (a) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$ (b) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$ (c) tan θ is directly proportional to hc / e, where h is Planck constant and c is the speed of light (d) The violet colour light can eject photoelectrons from metals 2 and 3 .



A. Ratio of work function, $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$

B. Ratio of work function, $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$

C. $\tan\theta$ is directely proportional to hc/e where h is planck's costant

and c is the speed of light

D. The violet colour light can eject photoelectrons form metals 2 and 3

Answer: a,c

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161. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut off voltage and the saturation current are respectively $0.6V$ and $18.0mA$ if the same source is placed $0.6m$ away from the photoelectric cell , then

A. the stopping potential will be 0.2 volt

B. the stopping potential will be 0.6 volt

C. the saturation current will be $6.0mA$

D. the saturation current will be $2.0mA$

Answer: b,d

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162. Which of the following charaterstics of photoelectric effect supports the particle nature of radiations

A. threshold frequency

B. instantaneous photoelectric emission

C. independent of the velocity of photoelectrons on intensity of radiations

D. dependence of the velocity of photoelectrons on frequency.

Answer: a,b,c,d

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163. The frequency and intensity of a light source are both doubled. Consider the following statements

A. The saturation photocurrent remains almost the same

B. The maximum kinetic energy of the photoelectrons is double

A. The saturation photocurrent gets double

B. The saturation photocurrent remains almost the same

C. The maximum K.E. of the photoelectron is more than doubled

D. The maximum K.E. of the photoelectrons gets double.

Answer: a,c

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164. If v is frequency, λ is the wavelength and $\bar{v}$ is the wave number then the energy of a photon can be represented by

A. hv

B. $hc\bar{v}$

C. $hc\lambda$

D. hc/λ

Answer: a,b,d

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165. In which of the following cases the heavier of the two particles has a smaller de-Broglie wavelength ? The two particles

A. move with same speed

B. move with the same kinetic energy

C. move with the same linear momentum

D. have fallen through the same height.

Answer: a,b,d

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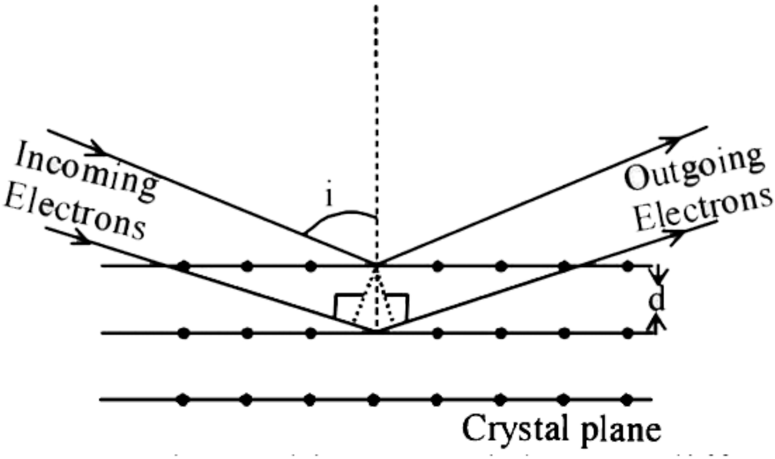
166. Wave property of electron implies that they will show diffraction effected . Davisson and Germer demonstrated this by diffracting electron from crystals . The law governing the diffraction from a crystals is obtained by requiring that electron waves reflected from the planes of atoms in a crystal interfere constructiely



Electron accelerated by potential V are diffracted from a crystal if $d = 1\text{Å}$ and $i = 30^\circ$, V should be about $\left(h = 6.6 \times 10^{-34} Js, m_e = 9.1 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C\right)$

A. $1000V$

B. $2000V$

C. $50V$

D. $500V$

Answer:

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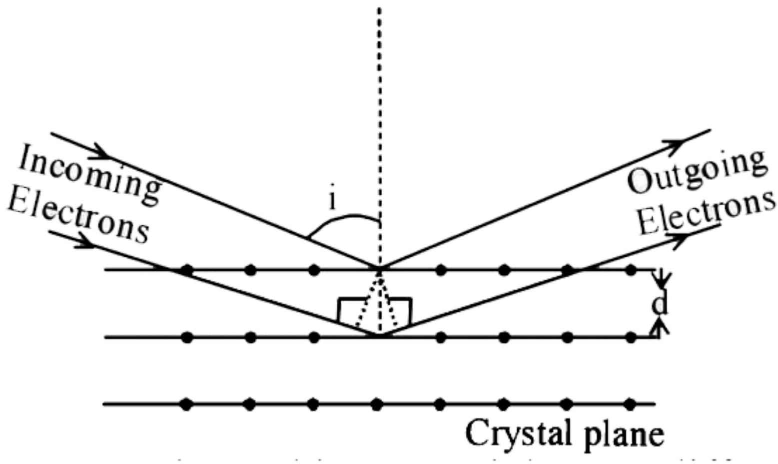
167. Wave property of electron implies that they will show diffraction effected . Davisson and Germer demonstrated this by diffracting electron from crystals . The law governing the diffraction from a crystals is obtained by requiring that electron waves reflected from the planes of atoms in a crystal inter fere constructiely



If a strong diffraction peak is observed when electrons are incident at an angle i from the normal to the crystal planes with distance d between them (see fig) de Brogle wavelength λ_{dB} of electrons can be calculated by the relationship (n is an intenger)

A. 30°

B. 15°

C. 45°

D. 60°

Answer:

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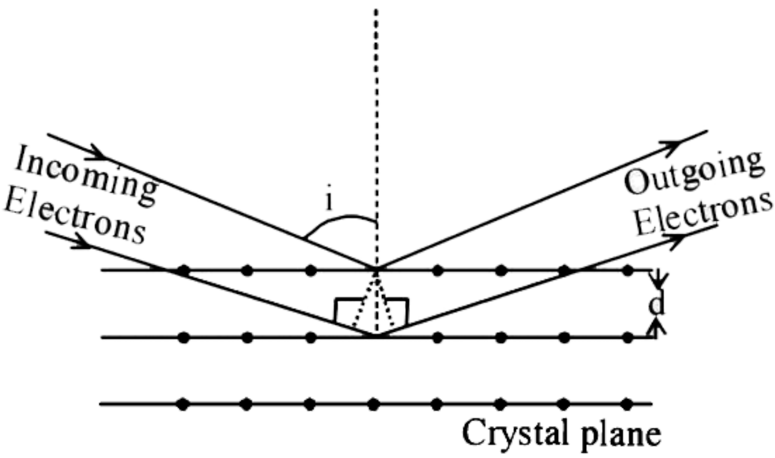
168. Wave property of electron implies that they will show diffraction effected . Davisson and Germer demonstrated this by diffracting electron from crystals . The law governing the diffraction from a crystals is obtained by requiring that electron waves reflected from the planes of atoms in a crystal inter fere constructiely



If a strong diffraction peak is observed when electrons are incident at an angle i from the normal to the crystal planes with distance d between them (see fig) de Brogle wavelength λ_{dB} of electrons can be calculated by the relationship (n is an intenger)

A. $d\cos i = n\lambda_{dB}$

B. $d\sin i = n\lambda_{dB}$

C. $2d\cos i = n\lambda_{dB}$

D. $2d\sin i = n\lambda_{nB}$

Answer:

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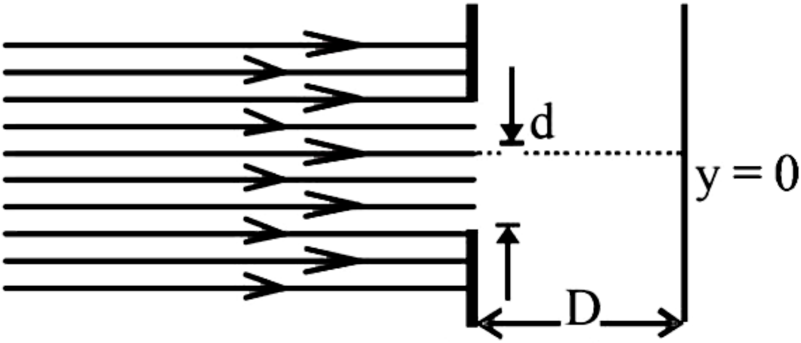
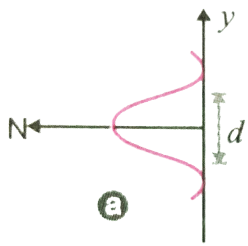
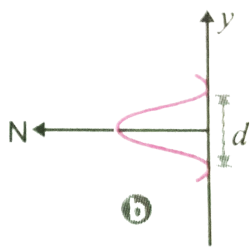
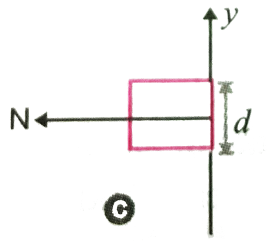
169. In an experiment, electrons are made to pass through a narrow slit of width d comparable to their de Broglie wavelength. They are detected on a screen at a distance D from the slit (see figure).

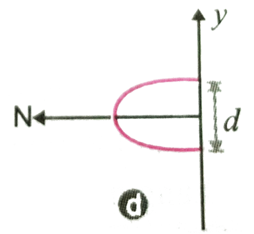


Which of the following graphs can be expected to represent the number of electrons N detected as a function of the detector position y (y=0 corresponds to the middle of the slit).

A. 

B. 

C. 

D. 

Answer:

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170. A silver of radius $1cm$ and work function $4.7eV$ is suspended from an insulating thread in freepace. It is under continuous illumination of $200nm$ wavelength light. As photoelectron are emitted the sphere gas charged and acquired a potential . The maximum number of photoelectron emitted from the sphere is $A \times 10^{e}(where 1 < A < 10)$ The value of z is

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171. 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

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172. The work function of Silver and sodium are $4.6 \text{ and } 2.3eV$, respectively . The ratio of the slope of the stopping potential versus frequency plot for silver to that of sodium is

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173. A $25wa$ bulb, which is producing monochromatic light of wavelength 6600Å is used to illuminated a metal surface. If the surface has 3%

efficiency for photoelectric effect, then the photoelectric current produced in deci ampere is (use $h = 6.6 \times 10^{-34} Js$):

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174. A parallel beam of monochromatic light of wavelength $600nm$ is incident on a totally reflecting plane mirror. The angle of incident is 60° and the number of photon striking the mirror per second is 2.0×10^{19}. The force exerted by the light beam on the mirror is $a \times 10^{-8} N$. what is the integer value of a? Given $h = 6.6 \times 10^{-34} Js$

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175. A proton is fired from very far away towards a nucleus with charge Q = 120 e, where e is the electronic charge. It makes a closest approach of $10 fm$ to the nucleus. The de - Broglie wavelength (in units of fm) of the proton at its start is take the proton mass, $m_p = 5/3 \times 10^{-27} kg, h/e = 4.2 \times 10^{-15} J - s/C,$
$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 m/F, 1 fm = 10^{-15}$.

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176. De-broglie wavelength associated with an electron accelerated through a potential difference $4V$ is λ_1.When accelerating voltage is decreased by $3V$, its de-broglie wavelength λ_2. The ratio $\lambda_2 / \lambda_1$is :

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177. Find the energy that should be added to an electron of energy 2eV to reduce its de-Broglie wavelength from 1nm to 0.5nm.

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178. Assertion: Light of frequency 1.5 times the threshold frequency is incident on photo-senstive material. If the frequency is halved and intensity is doubled, the photo current remains unchanged.

Reason: The photo electric current varies directely with the intensity of light and frequncy of light.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: d

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179. Assertion : Photoelectric effect demonstrates the wave nature of light.

Reason: The number of photoelectrons is proportional to the frequency of light.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: d

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180. Assertion: Photoecell is called electric eye.

Reason: Photocell can see tha things placed before it.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: c

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181. Assertion: An electron microscop can achieve better resolving power then an optical microscope.

Reason : The de-broglie wavelength of the electrons emitted form an electron gun with velocity $500m/s$ is much less than $500nm$.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: b

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182. Assertiom: The de-broglie wavelength of a neutrons when its kinetic energy is k is λ. Its wavelength is 2λ when its kinetic energy is $4k$.

Reason : The de-broglie wavelength λ is proportional to square root of the kinetic energy.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: d

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183. Assertion: The de-broglie wavelength equation has significance for any microscopic or submicroscopic particles.

Reason : The de-broglie wavelength is inversely proportional to the mass of the object if velocity is constant.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: a

184. Assertion: A particle of mass M at rest decays into two particles of masses m_1 and m_2, having non-zero velocities will have ratio of the de-broglie wavelength unity.

Reason: Here we cannot apply conservation of linear momentum.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: c

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185. Statement-1: The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.

Statement-2: The work function of the metal varies as a function of depth form the surface.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: a

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186. This question has statement - 1 and statement - 2 of the four choice given after the statements choose the one that best describes the two statements

statement - 1 : A metallic surface is irradiated by a monochromatic light of frequency $v > v_0$ (the threshold frequency). The maximum kinetic energy and the stopping potential are $K_{\max}$ and V_0 respectively if the frequency incident on the surface is doubled , both the $K_{\max}$ and V_0 are also doubled

statement - 2 : The maximum kinetic energy and the stopping potential of photoelectron emitted from a surface are linearly dependent on the frequency of incident light

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: d

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187. Statement - 1 : When ultraviolet light is incident on a photocell , its stopping potential is V_0 and the maximum kinetic energy of the photoelectrons is $K_{\max}$ when the ultraviolet light is replaces by X- rays both V_0 and $K_{\max}$ increase

Statement - 2 : Photoelectrons are emitted with speeds ranging from zero to a maximum value became of the range of frequencies present in the incident light

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: c

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188. Assertion : A laser beam $0.2W$ power can drill holes through a metal sheet, whereas $1000W$ torch-light cannot.

Reason : The frequency of laser light is much higher than that of torch light.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: c

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189. Statement-1: A small metal ball is suspended in a uniform electric field with an insulated thread. If high energy X-rays beam falls on the ball, the ball will be declected in the electric field.

Statement-2: X-rays emit photoelectrons and metal and metal becomes negatively charged.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: c

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190. Statement-1: An electron of mass m when accelerated through a potential difference V, has de-broglie wavelength λ. The de-broglie wavelength associated with a proton of mass M accelerated through the same potential difference will be $\lambda\sqrt{M/m}$.

Statement-2: de-broglie wavelength

$$\lambda = \frac{h}{\sqrt{2meV}}.$$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: d

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191. Statement-1: Davisson-Germer experiment established the wave nature of electron

Statement-2: If electrons have wave nature, they can interfere show differaction.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: a

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