PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

DUAL NATURE OF RADIATION AND MATTER

Example

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

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

(b) From which of the photosensitive materials with work functions listed in Table 11.1 and using the results of (i), (ii) and (iii) of (a), can you build a photoelectric device that operates with visible light?

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4. 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 traveling 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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5. 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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6. 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 identify the particle. Mass of electron $= 9.11 \times 10^{-31} kg$.

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7. What is de-Broglie wavelength of the electron accelerated through a potential difference of 100V?

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Exercises

1. 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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2. 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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3. The photoelectric cut off voltage in a certain experiment is 1.5V. What is the maximum kinetic energy of photoelectrons emitted? $e = 1.6 \times 10^{-19} C$.

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4. Monochromatic light of wavelength $632.8 nm$ 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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5. The energy flux of sunlight reaching the surface of the earth is $1.388 \times 10^3 \text{W/m}^2$. How many photons (nearly) per square metre are incident on the Earth per second ? Assume that the photons in the sunlight have an average wavelength of 550 nm.

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6. In an experiment on the photoelectric effect , the slope of the cut - off voltage versus frequency of incident light is found to be $4.12 \times 10^{-15} V$ s . The value of Planck's constant is

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7. A 100W sodium lamp radiates energy uniformly in all directions. The lamp is located at the center 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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8. The threshold frequency of a certain metal is $3.3 \times 10^{14} Hz$. If light of frequency $8.2 \times 10^{14} Hz$ 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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9. 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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10. 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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11. 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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12. Calculate the (a)momentum and (b) de - Brogile wavelength of the electrons accelerated through a potential difference of 56 V.

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13. 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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14. The wavelength of light from the spectral emission line of sodium is 589 nm. Find the kinetic energy at which

(i) an electron, and

(ii) a neutron, would have the same de-Broglie wavelength .

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15. What is the de-Broglie wavelength of (a) a bullet of mass $0.040 kg$ traveling 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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16. An electron and a photon each have a wavelength 1.00 nm. Find

(i) their momenta,

(ii) the energy of the photon and

(iii) the kinetic energy of electron.

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

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19. 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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20. (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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21. (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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22. An electron gun with its collector at a potential of 100 V fires out electrons in a spherical bulb containing hydrogen gas at low pressure (~10^{-2} mm of Hg). A magnetic field of 2.83×10^{-4} curves the path of the electrons in a circular orbit of radius 12.0 cm . (The path can be viewe because the gas ions in the path focus the beam by attracting electrons and emitting light by electron capture , the method is known as the 'fine beam tube ' method) Determine e/m from the data .

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23. (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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24. In an accelerator experiment on high energy collision of electrons with positrons, a certain events is interpreted as annihilation 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? $(1BeV = 10^9 eV)$

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25. 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 $(\text{~}10^{-10} Wm^{-2})$. Take the area of the pupil to be about

$0.4cm^2$, 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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26. Ultraviolet light of wavelength $2271Å$ from a 100W mercury source 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 $(\text{~}10^5 Wm^{-2})$ red light of wave length $6328Å$ produced by a He-Ne laser?

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27. Monochromatic radiation of wave length 640.2 nm $(1nm = 10^{-9}m)$ from a neon lamp irradiates a photosensitive 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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28. A mercury lamp is a convenient source 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 visible 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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29. 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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30. 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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31. Crystal diffraction experiments can be performed using X-rays, or electrons accelerated through appropriate voltage. Which probe has greater energy? An X-ray photon or the electron? (For quantitative comparison, 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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32. (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 diffraction 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 diffraction experiments.

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33. An electron microscope uses electrons accelerated by a voltage of 50 kV. Determine the de Broglie wavelength associated with the electrons. If other factors (such as numerical aperture, etc.) are taken roughly to be the same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light $(\lambda_y = 5.9 \times 10^{-7} m)$.

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34. 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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35. 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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36. 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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37. 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 ν, 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 ν λ) has no physical significance. Why?

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Examples

1. For the photoelectric emission from cesium, show that wave theory predicts that

maximum kinetic energy of the photoelectrons $(K_{\max})$ depends on the intensity I of the incident light

(Given : The work function for cesium is 1.90 eV and the power absorbed per unit area is $1.60 \times 10^{-6} \mathrm{~Wm}^{-2}$ which produces a measurable photocurrent in cesium.)

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2. For the photoelectric emission from cesium, show that wave theory predicts that

$K_{\max}$ does not depend on the frequency of the incident light.

(Given : The work function for cesium is 1.90 eV and the power absorbed per unit area is $1.60 \times 10^{-6} \mathrm{~Wm}^{-2}$ which produces a measurable photocurrent in cesium.)

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3. For the photoelectric emission from cesium, show that wave theory predicts that

the time interval between the incidence of light and the ejection of photoelectrons is very long.

(Given : The work function for cesium is 1.90 eV and the power absorbed per unit area is $1.60 \times 10^{-6} \text{ Wm}^{-2}$ which produces a measurable photocurrent in cesium.)

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4. A radiation of wavelength 300 nm is incident on a silver surface. Will photoelectrons be observed?

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5. When light of wavelength 2200Å falls on Cu, photo electrons are emitted from it. Find

the threshold wavelength

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6. When light of wavelength 2200Å falls on Cu, photo electrons are emitted from it. Find

the stopping potential. Given: the work function for Cu is $\phi_0 = 4.7 \text{ eV}$

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7. The work function of potassium is 2.2 eV. UV light of wavelength 3000Å and intensity 2 Wm^{-2} is incident on the potassium surface.

Determine the maximum kinetic energy of the photo electrons

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8. The work function of potassium is 2.2 eV. UV light of wavelength 3000Å and intensity $2 \quad \text{Wm}^{-2}$ is incident on the potassium surface. If 40% of incident photons produce photo electrons, how many electrons are emitted per second if the area of the potassium surface is $2 \quad \text{cm}^2$?

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9. Light of wavelength 390 nm is directed at a metal electrode. To find the energy of electrons ejected, an opposing potential difference is established between it and another electrode. The current of photoelectrons from one to the other is stopped completely when the potential difference is 1.10 V. Determine

the work function of the metal

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10. Light of wavelength 390 nm is directed at a metal electrode. To find the energy of electrons ejected, an opposing potential difference is established between it and another electrode. The current of photoelectrons from one to the other is stopped completely when the potential difference is 1.10 V. Determine

the maximum wavelength of light that can eject electrons from this metal.

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11. Calculate the momentum and the de Broglie wavelength in the following cases :

an electron with kinetic energy 2 eV.

Hence show that the wave nature of matter is important at the atomic level but is not really relevant at macroscopic level.

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12. Calculate the momentum and the de Broglie wavelength in the following cases :

a bullet of 50 g fired from rifle with a speed of 200 m/s

Hence show that the wave nature of matter is important at the atomic level but is not really relevant at macroscopic level.

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13. Calculate the momentum and the de Broglie wavelength in the following cases :

a 4000 kg car moving along the highways at 50 m/s

Hence show that the wave nature of matter is important at the atomic level but is not really relevant at macroscopic level.

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14. Find the de Broglie wavelength associated with an alpha particle which is accelerated through a potential difference of 400 V. Given that the mass of the proton is 1.67×10^{-27} kg.

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15. A proton and an electron have same de Broglie wavelength. Which of them moves faster and which possesses more kinetic energy ?

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16. Calculate the cut-off wavelength and cut-off frequency of x-rays from an x-ray tube of accelerating potential 20,000 V.

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Evaluation I Multiple Choice Questions

1. The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by

A. $\lambda_p \propto \lambda_e$

B. $\lambda_p \propto \sqrt{\lambda_e}$

C. $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$

D. $\lambda_p \propto \lambda_e^2$

Answer: D

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2. In an electron microscope, the electrons are accelerated by a voltage of 14 kV. If the voltage is changed to 224 kV, then the de Broglie wavelength associated with the electrons would

A. increase by 2 times

B. decrease by 2 times

C. decrease by 4 times

D. increase by 4 times

Answer: C

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3. A particle of mass $3 \times 10^{-6} g$ has the same wavelength as an electron moving with a velocity $6 \times 10^{6} \text{ m s}^{-1}$. The velocity of the particle is

A. $1.82 \times 10^{-18} \text{ m s}^{-1}$

B. $9 \times 10^{-2} \text{ m s}^{-1}$

C. $3 \times 10^{-31} \text{ m s}^{-1}$

D. $1.82 \times 10^{-15} \text{ m s}^{-1}$

Answer: D

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4. 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 $\frac{V}{4}$. Th e threshold wavelength for the metallic surface is

A. 4λ

B. 5λ

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

D. 3λ

Answer: D

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5. If a light of wavelength 330 nm is incident on a metal with work function 3.55 eV, the electrons are emitted. Th en the wavelength of the emitted electron is (Take $h = 6.6 \times 10^{-34} \text{ Js}$)

A. $< 2.75 \times 10^{-9} m$

B. $\geq 2.75 \times 10^{-9} m$

C. $\leq 2.75 \times 10^{-12} m$

D. $< 2.5 \times 10^{-10} m$

Answer: B

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6. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\lambda/2$. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the fi rst case, the work function at the surface of material is

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

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

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

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

Answer: D

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7. In photoelectric emission, a radiation whose frequency is 4 times threshold frequency of a certain metal is incident on the metal. Then the maximum possible velocity of the emitted electron will be

A. $\sqrt{\frac{hv_0}{m}}$

B. $\sqrt{\frac{6hv_0}{m}}$

C. $2\sqrt{\frac{hv_0}{m}}$

D. $\sqrt{\frac{hv_0}{2m}}$

Answer: B

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8. Two radiations with photon energies 0.9 eV and 3.3 eV respectively are falling on a metallic surfacesuccessively. If the work function of the metal is 0.6 eV, then the ratio of maximum speeds of emitted electrons will be

A. $1:4$

B. $1:3$

C. $1:1$

D. $1:9$

Answer: B

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9. A light source of wavelength 520 nm emits 1.04×10^{15} photons per second while the second source of 460 nm produces 1.38×10^{15} photons per second. Then the ratio of power of second source to that of first source is

A. 1.00

B. 1.02

C. 1.5

D. 0.98

Answer: C

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10. The mean wavelength of light from sun is taken to be 550 nm and its mean power is $3.8 \times 10^{26} W$. The number of photons received by the human eye per second on the average from sunlight is of the order of

A. 10^{45}

B. 10^{42}

C. 10^{54}

D. 10^{51}

Answer: A

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11. The threshold wavelength for a metal surface whose photoelectric work function is 3.313 eV is

A. 4125Å

B. 3750Å

C. 6000Å

D. 2062.5Å

Answer: B

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12. A light of wavelength 500 nm is incident on a sensitive plate of photoelectric work function 1.235 eV. The kinetic energy of the photo electrons emitted is be (Take $h = 6.6 \times 10^{-34}\ \text{Js}$)

A. $0.58\ \text{eV}$

B. $2.48\ \text{eV}$

C. $1.24\ \text{eV}$

D. $1.16\ \text{eV}$

Answer: C

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13. Photons of wavelength λ are incident on a metal. The most energetic electrons ejected from the metal are bent into a circular arc of radius R by a perpendicular magnetic field having magnitude B. The work function of the metal is

A. $\frac{hc}{\lambda} - m_e + \frac{e^2 B^2 R^2}{2m_e}$

B. $\frac{hc}{\lambda} + 2m_e \left[\frac{\text{eBR}}{2m_e}\right]^2$

C. $\frac{hc}{\lambda} - m_e c^2 - \frac{e^2 B^2 R^2}{2m_e}$

D. $\frac{hc}{\lambda} - 2m_e \left[\frac{\text{eBR}}{2m_e}\right]^2$

Answer: D

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14. The work functions for metals A, B and C are 1.92 eV, 2.0 eV and 5.0 eV respectively. The metals which will emit photoelectrons for a radiation of wavelength 4100Å is/are

A. A only

B. both A and B

C. all these metals

D. none

Answer: B

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15. Emission of electrons by the absorption of heat energy is called . . . . . . emission.

A. photoelectric

B. field

C. thermionic

D. secondary

Answer: C

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Evaluation Iv Numerical Problems

1. How many photons per second emanate from a 50 mW laser of 640 nm ?

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2. Calculate the maximum kinetic energy and maximum velocity of the photoelectrons emitted when the stopping potential is 81V for the photoelectric emission experiment.

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3. Calculate the energies of the photons associated with the following radiation: (i) violet light of 413 nm (ii) X-rays of 0.1 nm (iii) radio waves of 10 m.

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4. A 150 W lamp emits light of mean wavelength of 5500Å. If the efficiency is $12\,\%$, find out the number of photons emitted by the lamp in one second.

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5. How many photons of frequency 10^{14} Hz will make up 19.86 J of energy?

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6. What should be the velocity of the electron so that its momentum equals that of 4000Å wavelength photon

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7. When a light of frequency 9×10^{14} Hz is incident on a metal surface, photoelectrons are emitted with a maximum speed of 8×10^{5} ms^{-1} Determine the threshold frequency of the surface

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8. When a 6000Å light falls on the cathode of a photo cell and produced photoemission. If a stopping potential of 0.8 V is required to stop emission of electron, then determine the (i) frequency of the light (ii) energy of the incident photon (iii) work function of the cathode material (iv) threshold frequency and (v) net energy of the electron after it leaves the surface.

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9. A 3310Å photon liberates an electron from a material with energy 3×10^{-19}J while another 5000Å photon ejects an electron with energy 0.972×10^{-19} J from the same material. Determine the value of Planck's constant and the threshold wavelength of the material

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10. At the given point of time, the earth receives energy from sun at $4 \text{ cal cm}^{-2} \text{ min}^{-1}$. Determine the number of photons received on the surface of the Earth per cm^2 per minute. (Given : Mean wavelength of sun light $= 5500\text{Å}$)

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11. UV light of wavelength 1800Å is incident on a lithium surface whose threshold wavelength 4965Å Determine the maximum energy of the electron emitted.

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12. Calculate the de Broglie wavelength of a proton whose kinetic energy is equal 81.9×10^{-15} J. (Given: mass of proton is 1836 times that of electron).

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13. A deuteron and an alpha particle are accelerated with the same potential. Which one of the two has (i) greater value of de Broglie wavelength associated with it and (ii) less kinetic energy? Explain.

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14. An electron is accelerated through a potential difference of 81V. What is the de Broglie wavelength associated with it ? To which part of electromagnetic spectrum does this wavelength correspond?

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15. The ratio between the de Broglie wavelengths associated with protons, accelerated through a potential of 512 V and that of alpha particles accelerated through a potential of X volts is found to be one. Find the value of X.

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