



# PHYSICS

# **BOOKS - CENGAGE PHYSICS (HINGLISH)**

## **DUAL NATURE OF RADIATION AND MATTER**

Question Bank

**1.** Lights of two different frequencies whose photons have energies 1eVand 2.5eV illuminate a metallic surface whose work function is 0.5eVsuccessively. The ratio of maximum speed of emitted electrons in the first case to that in the second case will be

2. The Davisson-Germer experiments that first demonstrated the wave nature of matter used electron accelerated to 54eV. The wavelength (in  $A^o$ ) of the electrons in the Davisson-Germer experiment is

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**3.** If the potential differenceappliedtoan X-raytubeis 5kV and the current through it is 6.4mA, then number of electrons striking the target per second is  $y \times 10^{16}$ . Find y.



**4.** When a metallic surface is illuminated with monochromatic light of wavelength  $\lambda$ , the stopping potential is  $5V_0$ . When the same surface is illuminated with light of wavelength  $3\lambda$ , the stopping potential is  $V_0$ . The work function of the metallic surface is  $\frac{hc}{k\lambda}$ . Find k.

5. A 200W sodium street lamp emits, yellow light of wavelength  $0.6\mu m$ . Assuming it to be 25% efficient in converting electric energy to light, the númber of photons of yellow light it emits per second is  $n \times 10^{20}$ . Find n.

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6. Light with an enargy flux of  $25 \times 10^4 Wm^{-2}$  falls on a perfectly reflecting surface at normal incidence. If the surface area is  $15cm^2$ , the average force exerted on the surface is

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**7.** 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

8. A certain metallic surface is illuminated with monochromatic light of wavelength  $\lambda$ . The stopping potential for photoelectric current for this light is  $3V_0$ . If the same surface is illuminated with light of wavelength  $2\lambda$ , the stopping potential is  $V_{0^\circ}$ . The threshold wavelength for this surface for photoelectric effect is  $y\lambda$ . Find y.

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**9.** Photons with energy 5eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted photoelectrons is 2eV. When photons of energy 6eV are incident on C, no photoelectrons will reach the anode A, if the stopping potential of A relative to C is

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**10.** The kinetic energy of most energetic electrons emitted from a metallic surface is doubled when the wavelength  $\lambda$  of the incident radiation is changed from 400 nm to 310 nm. The work function of the metal is



**11.** Work function of potassium metal is 2.30 eV . When light of frequency  $8 \times 10^{14}$  Hz is incident on the metal surface, photoemission of electrons occurs. The stopping potential of the electrons will be equal to

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12. The threshold frequency for a certain photosensitive metal is  $v_0$ . When it is illuminated by light of frequency  $v = 2v_0$ , the maximum velocity of photoelectrons is  $v_0$ . The maximum velocity of the photoelectrons when the same metal is illuminated by light of frequency  $v = 5v_0$  is  $xv_0$ . Find x



**13.** X-rays are incident normally on a crystal of lattice constant 0.6nm. The first order reflection on diftion from the crystal occurs at an angle of  $30^{\circ}$ . The wavelength of the X-ray used is  $\alpha$  nano-metre. Find  $10\alpha$ .

**14.** The de-Broglie wavelength of electrons striking the cathode to produce X-rays is equal to  $\frac{1}{100}$  of minimum wavelength of X-ray produced. What is the voltage (in volt) across X-ray tube?

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**15.** Suppose the energy of  $K_a$  X-rays of two elements P and Q are 826.2eV and 2947.8eV, respectively, then the number of elements lying between P and Q according to their atomic number is

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**16.** What is the wavelength of a beam of X -rays (in  $A^o$ ) which is difted by a crystal in a direction making an angle of  $60^\circ$  with the incident beam and corresponding to first order reflection from crystal lattice planes separated by  $3 \times 10^{-10} m$ ? 17. Light of wavelength  $\lambda$  from a small 0.5mW He-Ne laser source is used in the school laboratory to shine on perfectly absorbing surface of a spacecraft of mass 1000kg. The tine needed' for the spacecraft to reachi a velocity of  $1k\frac{m}{s}$  from rest is given by  $\alpha \times 10^{\beta}(s)$  in scientific notation. Find the value of  $(\beta - r2\alpha)$ .

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**18.** A plate of mass 20mg is in equilibrium in air due to force exerted by light beam on the plate as shown is the figure. Calculate the power of the beam (in mega-watt) if the plate is perfectly absorbing.

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**19.** Moseley's law for  $K_{\alpha}$  photon is given by  $\sqrt{v} = a(Z - b)$  where a is a universal constant and b is a screening constant. Moseley's logic helps us assume b = 1 for  $K_{\alpha}$  photon. If there is a percentage error  $= 10^{-2}$  in the measurement of b due to actual orbital configuration of an atom, then the relative error in the measurement of v if Z = 51 is  $p \times 10^{-q}$ . Find the value of (pq)

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**20.** When photons of energy 4.25eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy,  $T_A$  (expressed in eV) and deBroglie wavelength  $\lambda_A$ . The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.20V is  $T_B = T_A - 1.50 eV$ . If the deBroglie wavelength of those photoelectrons is  $\lambda_B = 2\lambda_A$  then

**21.** In the figure shown, electromagnetic radiations of wavelength 200nm are incident on the metallic plate A. The photoelectrons are accelerated by a potential difference of 10V. These electrons strike another metal plate B from which electromagnetic radiations are emitted. The minimum wavelength of the emitted photons is 100nm. Find the work function of the metal A (in eV). (Use  $hc = 12400eVA^o$ , Rch = 13.6eV)

'(##CEN\_KSR\_PHY\_JEE\_CO28\_E01\_022\_Q02##)' FIGURE

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**22.** A smail plate of area  $1cm^2$  is placed at a distance of  $\frac{1}{\sqrt{\pi}}$  metre from an isotropic point source emitting light of frequency  $\frac{1}{6.63} \times 10^{14} Hz$ , at a power of 2.00mW. Assuming the plate to be normal to the incident photons, the rate of photons striking the plate is ) p xx 10^(12) per second. Find p (h=6.63xx10^(-34) J s)

**23.** When a monochromatic point source of light is at a distance 0.2m from a photoelectric cell, the saturation current and cut-off voltage are 12.0mA and 0.5V, respec tively. If the same source is placed 0.4m away from the photoelectric cell, then the saturation current is x milli-ampere and the stopping. potential is y volt. Find  $\frac{x}{y}$ .

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**24.** A small metal plate of area  $2cm^2$  is placed at a distance of 2m from a monochromatic light source of  $\lambda = 1000A^o$ , power rating of 100W, light energy conversion efficiency of 10% and emitting light uniformly in all directions. Light falls normally on the plate having work function,  $\phi = 10eV$  ). Assuming one out of  $10^6$  photons is able to eject a photoelectron, the saturation current is  $n \times 10^{-12}$  ampere. Find n.

**25.** A light of wavelength  $3540A^{\circ}$  falls on a metal having work function of 2.5eV. The ejected electron collides with another target metal inelastically and its total kinetic energy is utilized to raise the temperature of target metal. The mass of target metal is  $10^{-3}kg$  and its specific heat is  $160jkg^{-1}C^{-1}$ . If  $10^{\circ}(18)$   $e \leq ctronsareejected per sec ond, then <math>f \in dtherate of raise of temperatur overset(o)C of them <math>\eta$ !.  $(As \sum ethere is no loss of e \neq rgy of ejected e \leq ctron by any other h c=12400eV A^o`)$ 

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**26.** A cooling object was emitting radiations of time varying wavelength  $\lambda = 3000 + 40t$ , where  $\lambda$  is in  $\forall$  and t is in second. The radiation is incident on a metal sheet of work function 2eV, such that the power incident on the sheet is constant at 100W. This radiation is switched on and off for time intervals of 2 min and 1 min, respectively. Each time the radiation is switched on,  $\lambda$  again starts from fresh value of  $3000A^o$ . If the

metal sheet is grounded so that it always remains neutral and electron clouding is negligible, then find the maximum photocurrent (in mA ). The photoemission efficiency is 0.01% and remains constant. (Take  $hc = 12400 eVA^o$ )

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**27.** A parallel. beam of light of intensity I is incident normally on a plane surface A which absorbs 50 % of the incident light. The reflected light fails on B which is perfect reflector. The light reflected by B is again partly reflected and partly absorbed and this process continues. For all absorption by  $\dot{A}$ , absorption coefficient is 0.5. The pressure experienced by A due to light is  $\frac{kI}{c}$ . Find k. '(##CEN\_KSR\_PHY\_JEE\_CO28\_E01\_028\_Q03##)' (Here, c = speed of light ) FIGURE

**28.**  $(An)^2(X)$  -ray tube operates at 50(kV). Consider that at each collision, an electron converts 50 % of its energy into photons and 10 % energy would be dissipated as thermal energy. The wavelength (in  $\forall$ ) of emitted photons during  $2^{nd}$  collision is (Take hc = 1242eV(nm)). Answer up to two places of decimal)

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**29.** In a photoelectric set up, the most energetic photoelectron from the material is introduced horizontally parallel to the parallel plate capacitor of length l and constant electric field E. The photoelectron gets deflected by d when it emerges ouit from the capacitor. The stopping potential for this electron is  $\frac{x E l^2}{8d} eV$ . Find x (neglecting the effect of gravity).

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**30.** A metal plate has work function of 6eV. Light of wavelength 200nm falls on the plate. Photoelectrons are emitted in all possible directions. A

magnetic field of 1T exists parallel to the plate as shown. What can be the maximum possible distance (in  $\mu m$ ) (in direction perpendicular to plate) from the plate surface reached by emitted photoelectrons? (Take mass of electron,  $m_e = 9 \times 10^{-31} kg$ ).

'(##CEN\_KSR\_PHY\_JEE\_CO28\_E01\_031\_Q04##)'