JEE Main Practice Test-19
Atomic Physics, Photoelectric Effect

Topic : Atomic Physics

Time: 0:75 Hr Marking +4 –1

Photoelectric Effect, Atomic Strucutre, Dual Nature of Light & X-Rays

Section - A : MCQs with Single Option Correct

1. A hydrogen atom at rest emits a photon during its transition from $n = 2$ to $n = 1$. Choose the **INCORRECT** statement :
(A) De-Broglie wavelength of hydrogen atom during recoil will be same as wavelength of emitted photon
(B) Energy of emitted photon will be less than 10.2 eV
(C) Kinetic energy of recoil H-atom will be less than 10.2 eV
(D) Kinetic energy of recoil H-atom will be equal to energy of emitted photon

2. If electronic charge on electron alone is doubled then as per Bohr model, K.E. of an e^- revolving in the n^{th} orbit becomes
(A) Remains same (B) Becomes 2 times (C) Becomes 4 times (D) Becomes 16 times

3. The ionization energy of hydrogen atom in its ground state is :
(A) 13.6 eV (B) 6.8 eV (C) 10.2 eV (D) None

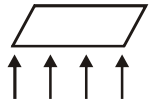
5. A Laser light of wavelength 600 nm is used to weld retina detachment. If a Laser pulse of width 60 ms and power 0.5 kW is used the approximate number of photons in the pulse are : [Take Plank's constant $h = 6.62 \times 10^{-34}$ Js]
(A) 10^{20} (B) 10^{18} (C) 10^{22} (D) 10^{19}

6. Surface of certain metal is first illuminated with light of wavelength $\lambda_1 = 350$ nm and then, by light of wavelength $\lambda_2 = 540$ nm. It is found that the maximum speed of the photo electrons in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to : [Energy of photon = $\frac{1240}{\lambda(\text{in } nm)}$ eV]
(A) 1.8 (B) 1.4 (C) 2.5 (D) 5.6

7. The magnetic field associated with a light wave is given, at the origin, by
$B = B_0 [\sin (3.14 \times 10^7) ct + \sin(6.28 \times 10^7) ct]$.
If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons? ($c = 3 \times l0^8 ms^{-1}$, $h = 6.6 \times 10^{-34}$ J-s) :
(A) 7.72 eV (B) 8.52 eV (C) 12.5 eV (D) 6.82 eV

8. A metal plate of area 1×10^{-4} m^2 is illuminated by a radiation of intensity 16 mW/m^2. The work function of the metal is 5 eV. The energy of the incident photons is 10 eV and only 10% of it produces photo electrons. The number of emitted photo electrons per second and their maximum energy, respectively, will be. [1 eV = 1.6×10^{-19} J] :
(A) 10^{10} and 5 eV (B) 10^{14} and 10 eV (C) 10^{12} and 5 eV (D) 10^{11} and 5 eV

9. A plate of mass 20 gm is in equilibrium in air due to force exerted by light beam on plate as shown is figure. Calculate power of the beam if plate is perfectly absorbing.
(A) 7×10^7 W (B) 6×10^8 W
(C) 6×10^7 W (D) 7×10^8 W



10. Rank the vernier callipers/screw gauge in the order of their increasing precision :
(1) Screw gauge having main scale division 1 mm and no. of circular division = 200.
(2) Screw gauge having main scale division 0.5 mm and no. of circular division = 400.
(3) Vernier callipers having main scale division = 1 mm such that 9 MSD = 10 VSD.
(4) Vernier callipers having main scale division = 1 mm such that 4 MSD = 5 VSD.
(A) $4 < 2 < 3 < 1$ (B) $2 < 4 < 1 < 3$ (C) $4 < 3 < 2 < 1$ (D) $4 < 3 < 1 < 2$

11. A photon of wavelength 12.4 nm is used to emit an electron from the ground state of He^+. The de-Broglie wavelength of the emitted electron is :
(A) 1.2 Å (B) 1.81 Å (C) 2.5 Å (D) 2.3 Å

12. Light emitted from a star (assumed to be a black body) has a maximum intensity at wavelength λ. If a helium gas sample has same temperature as that of the star, de-Broglie wavelength of its atoms moving at v_{rms} would be proportional to :

(A) $\sqrt{\lambda}$ (B) $\frac{1}{\sqrt{\lambda}}$ (C) λ^2 (D) $\frac{1}{\lambda^2}$

13. A sodium atom emits a photon of wavelength 590 nm and recoils with velocity v equal to :
(A) 0.029 m/s (B) 0.048 m/s (C) 0.0023 m/s (D) Data inadequate

14. Electron microscope works on principle of :
(A) wave nature of light (B) particle nature of light (C) wave nature of electron (D) particle nature of electron

15. Two particle (same charged) with masses m and $3m$ are accelerated through same potential difference. The ratio of the de-Broglie wavelength associated with m & $3m$ respectively is :

(A) 1 : 3 (B) 3 : 1 (C) $1 : \sqrt{3}$ (D) $\sqrt{3} : 1$

16. In an X-ray tube the electrons are expected to strike the target with a velocity that is 10% of the velocity of light. The applied voltage should be :
(A) 517.6 V (B) 1052 V (C) 2.559 kV (D) 5.680 kV

17. A beam of 28 keV electrons strikes a target generating X-rays. The minimum wave length λ_{min} (called cutoff wavelength) of the X-rays generated is :
(A) 4.4 nm (B) 44 nm (C) 0.044 nm (D) 0.44 nm

18. When electrons accelerated by 400 V are diffracted by a crystal, the angular diffraction pattern is identical with that produced by X-rays of wavelength 0.61 Å calculate the plank's constant :
(A) 6.90×10^{-34} Js (B) 6.59×10^{-34} Js (C) 2.08×10^{-32} Js (D) 6.65×10^{-34} Js

19. Mark the correct statements regarding X-rays :
(A) When fast moving electron air striking the metal target, they enter the metal target and in a very short time comes to rest, and thus an accelerated charge (electron) produces em waves (X-rays)
(B) Characteristic X-rays are produced due to transition of electron from higher energy level to vacant lower energy level
(C) X-ray spectrum is a discrete spectra just like hydrogen spectra
(D) Both (A) & (B) are correct

20. If f_1, f_2 and f_3 are the frequencies of corresponding K_α, K_β and L_α X-ray of an element, then :
(A) $f_1 = f_2 = f_3$ (B) $f_1 - f_2 + f_3$ (C) $f_2 = f_1 + f_3$ (D) $f_2 = f_1 f_3$

Section- B: INTEGER Answer Type Questions

21. Electrons with maximum kinetic energy of 3 eV are ejected from a metal surface by ultraviolet radiation of wavelength 1500Å. Determine the work function of the metal, the threshold wavelength and the retarding potential difference required to stop the emission of electrons.

22. A hydrogen atom, initially in the ground state is excited by absorbing a photon of wavelength 1240 Å. The radius of the atom in the excited state, in terms of Bohr radius a_0, will be na_0. Find n. [hC = 12400 eV – Å]

23. Ionization potential of hydrogen atom is 13.6 V. Hydrogen atoms in the ground state are excited with monochromatic radiation of photon of energy 12.75 eV. Calculate the number of spectral lines emitted by hydrogen atoms according to Bohr's theory.

24. When light of wavelength λ_1 is incident on the cathode of a photoelectric tube, the maximum kinetic energy of the emitted electrons is 1.75 eV. If the wavelength is reduced to $\lambda_1/2$, the maximum kinetic energy of the emitted electrons is 5.5 eV. Find the work function ϕ of the cathode materia in eV.

25. When a metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential is 5 V_0. When the same surface is illuminated with light of wavelength 3λ, the stopping potential is V_0. Then the work function of the metallic surface is $\frac{hc}{n\lambda}$. Find n.

26. Electromagnetic radiation falls on a metallic body whose work function is 2 eV. For a particular radiation of frequency ν, the maximum kinetic energy of the photoelectron is found to be 4 eV. Find the maximum kinetic energy (in eV) of photoelectron for the radiation of frequency $\frac{5\nu}{3}$.

27. The wavelength of K_α X-ray from an element of atomic number 41 is λ, then the wavelength of K_α X-ray from an element of atomic number 21 is $n\lambda$. Find n.

28. A particle A of mass m and charge q is accelerated by a potential difference of 100 V. Another particle B of mass 16 m and charge $10q$ is accelerated by a potential difference of 4000 V. Calculate the ratio of de-Broglie wavelengths $\frac{\lambda_A}{\lambda_B}$ to the closest integer value.

29. The peak emission from a block body at a certain temperature occurs at a wavelength of 6200 Å. On increasing its temperature, the total radiation emitted is increased 16 times. These radiations are allowed to fall on a metal surface. Photoelectrons emitted by the peak radiation at higher temperature can be bought to rest by applying a potential equivalent to the excitation potential corresponding to the transition for the level $n = 4$ to $n = 2$ in the Bohr's hydrogen atom. The work function of the metal is given by $\frac{\alpha}{100}$ eV where α is a numerical constant. Calcuate the value of $\alpha/29$.

30. Suppose radiation from a black body is allowed to fall on a photosensitive material after passing it through a filter which selects the wavelength having maximum intensity to pass. The work-function of the material is 1.24 eV. Find the minimum temperature (in 10^3 K) of the black-body which will cause the emission of photo-electrons. (Given Weins constant $b = 3 \times 10^{-3}$ m-K & hc = 12400 eV-Å)

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ANSWER KEY

Section - A : MCQs with Single Option Correct

1. (D)	**2.** (C)	**3.** (A)	**4.** (C)
5. (A)	**6.** (A)	**7.** (A)	**8.** (D)
9. (C)	**10.** (D)	**11.** (B)	**12.** (A)
13. (A)	**14.** (C)	**15.** (D)	**16.** (C)
17. (C)	**18.** (C)	**19.** (B)	**20.** (C)

Section- B: INTEGER Answer Type Questions

21. [3]	**22.** [4]	**23.** [6]	**24.** [2]
25. [6]	**26.** [8]	**27.** [4]	**28.** [80]
29. [5]	**30.** [3]		

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