IIT-JEE / MEDICAL

PHYSICS

QUESTIONS

Dual Nature of Matter

By

BHARAT BHUSHAN @ B. K. NAL
Assistant Professor (Computer Science)
Director, BSTI, Kokar

&

SUPRIYA BHARATI
Assistant Professor (Computer Science)
Asst. Director, BSTI, Kokar

Buddha Science & Technical Institute
Kokar, Ranchi-834001, Jharkhand, India
www.bharatsir.com

VERY SHORT ANSWER QUESTIONS

1. Define threshold frequency.
2. Defined threshold wavelength.
3. For photoemission should the wavelength of incident radiation greater than or less than the threshold wavelength.
4. Is photoelectric emission possible at all frequencies? Give reasons.
5. The wavelength of incident photon is λ and work function of metallic surface is W ; what is the maximum kinetic energy of emitted photoelectrons ? What is the minimum kinetic energy?

   [**Ans :** $(E_k)_{\max} = \frac{hc}{\lambda} - W, (E_k)_{\min} = 0$]
6. Define stopping potential.
7. The maximum kinetic energy of photoelectrons is 6 eV. What is the value of stopping potential?

   [**Ans :** 6 V]
8. The work function of metal is 2 eV . Can a 3 eV- photon emit photoelectrons from this metal ? Can two photons , each of energy 1.5 eV , emit photoelectrons from this surface?

   [**Ans :** Yes , No]
9. Show graphically how the (i) stopping potential (ii) maximum kinetic energy , for a given photosensitive surface varies with the frequency of incident radiation.
10. What is the slope of graph of stopping potential versus frequency of incident radiation?
11. The work functions of two metals A and B are 2 eV and 5 eV respectively . Which of these is suitable for photoelectric cell using visible light?

    [**Ans :** A]
12. What is the slop of maximum kinetic energy verses frequency of incident radiation?
13. Can you tell the relation of graphs of stopping potential versus frequency of two different metals , A and B.

    [**Ans :** The graphs are parallel straights lines]
14. Write Einstein's photoelectric equation.
15. For same frequency of incident and given metal , how does photocurrent vary with increase of intensity?
16. For same frequency of incident radiation and given metal how does stopping potential vary with increase of intensity?
17. For given metal, how does photoelectric vary with increase of frequency of incident radiations provided its intensity is kept same?
18. For a given metal , how does stopping potential vary with increase of frequency of incident radiation provided its intensity is kept same?
19. What affects the photocurrent : intensity or frequency of incident radiation?
20. What affects the maximum kinetic energy of photoelectrons : intensity or frequency of incident radiation?

21. What is the relation between work function and threshold frequency for a metal?
22. A metal A just emits photoelectron with radiation of wavelength λ_0=400nm . Can it emit photoelectrons with radiation wavelength (i) 500 nm (ii) 300 nm?
23. State de Broglie hypothesis .
24. How does de Broglie weave length depends on velocity of associated particle?
25. Can neutrons have as waves?
26. Why does wave nature of particles not observed in daily experiences?
27. What is de Broglie wavelength of a particle having momentum 6.6 x 10^{-24} kg-m/s?
    [**Ans :** 1 A^0]
28. An electron and a proton have same kinetic energy .Which of the two has greater de Broglie wavelength ?
    [**Ans :** electron]
29. Wavelength of electromagnetic radiation is doubled . What happens to the energy of photon?
30. The kinetic energy of a material particle is doubled ; what happens to the de Broglie wavelength ?

SHORT ANSWER QUESTIONS

1. What is photoelectric effect ? Define work function , threshold frequency , stopping potential .
2. Write assumption of Einstein to explain photoelectric effect ; hence derive Einstein's photoelectric equation.
3. Define stopping potential , threshold frequency and work function of a metal.
4. Using Einstein's photoelectric equation , explain characteristics of photoelectric effect.
5. A metallic surface just emits photoelectrons with green light . How does maximum kinetic energy change if incident radiation is changed violet , blue , yellow , red ?
6. If intensity of incident radiation on a metallic surface is doubled , what happen to photocurrent and maximum kinetic energy of emitted electrons ?
7. If the frequency and intensity of incident radiation on a metallic surface are doubled , do the maximum kinetic energy and photocurrent get doubled? Explain with reason.
8. Draw a graph showing the variation of maximum kinetic versus frequency of incident light . What is the shape and slope of the graph?
9. What is a photocell ? Explain the functioning of a photocell. Give its two uses.
10. State two laws of photoelectric effect. Are cathode rays waves or particles?
11. The work function of three elements A,B and C are given below :

    A = 5.0 eV , B = 3.8 eV , C = 2.8 eV

    A radiation of wavelength 4125 A^0 is made to be incident on each of these elements .Show by appropriate calculations in which case photoelectrons will not be emitted.

12. A source of light is placed at a distance of 0.50 m from the photocell used and the cut-off potential is found to be V_0. If the distance between the light source and photocell is made 0.25m , what will be the new cut-off potential?
[Ans : V_0. The reason is , by chan

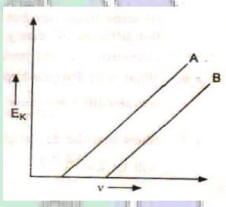
13. A proton and an α-particle are accelerated through the same potential difference , calculate the ratio of de Broglie wavelength associated with them.
[**Ans :** $\sqrt{8}:1$]

14. A mixture of three waves of wavelength λ_1 , λ_2 and λ_3 (such that $\lambda_1 > \lambda_2 > \lambda_3$) is made incident on a metal surface of threshold wavelength λ_2 . if number of photons of each wavelength is 10^6 and efficiency of photoelectric effect is 1%. Calculate the number of photoelectrons emitted.
[**Ans :** 2×10^4]

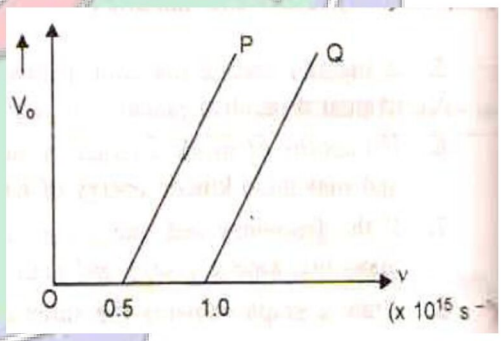
15. A proton and an electron have same de Broglie wavelength .Explain which has the greater total energy?
[**Ans :** Electron]

16. Every metal has a define work function . Why do all photoelectrons not come out with the same energy even if incident radiation is monochromatic ? Why is there an energy distribution of photoelectrons.
[**Ans :** (i) B , (ii) Plank's constant *h.* (iii) A]

17. The plots of maximum kinetic energy versus frequency graphs of two metals A and B are shown in figure.
(i) Which of the metals has greater work function?
(ii) What does the slop of the line depict?
(iii) For which of the metals will the stopping potential be more , for the same frequency of incident radiation?



18. The following graphs shows the variation of the stopping potential V_0 with frequency ν of the incident radiation for two photosensitive metals P and Q.
(i) Explain which metal has smaller threshold wavelength.
(ii) Explain giving reason , which metal emits photoelectrons having smaller kinetic energy.
(iii) If the distance between the light source and the metal P is doubled , how will the stopping potential change?



[**Ans :** (i) P (ii) Q (iii) No Change]

19. An electron an α-particles and a proton have the same de Broglie wavelength .Which of these particles has (i) the minimum kinetic energy (ii) the maximum kinetic energy and why ? In what way has the wave nature of electron been exploited in electron microscope?
[**Ans :** (i) α-Particle (ii) electron de Broglie wavelength is much smaller than optical wavelength]

20. A photon of wavelength λ is incident on a metal .If the electron emitted has the same energy as that of photon , what is the relation of associated de Broglie wavelength and wavelength λ.

LONG ANSWER QUESTIONS

1. State the laws of photoelectric effect. How have they been explained by Einstein?
2. Obtain Einstein's photoelectric equation. Explain how it enables us to understand the (i) linear dependence of the maximum kinetic energy of the emitted electrons on the frequency of incident radiation.
   (ii) existence of the threshold frequency for given photoemitter.
3. Describe the photocell and mention some of its applications.
4. What is photoelectric effect? Explain experimentally the variation of photoelectric current with
   (i) Intensity of light
   (ii) The p .d. between the plates.
   (iii) Frequency of incident light and hence state the laws of photoelectric emission.
5. Draw graphs showing the variation of photoelectric current with anode potential of a photocell for
   (i) Same frequency but different intensities $I_1 > I_2 > I_3$ of incident radiation.
   (ii) Same intensity frequency but different $\nu_1 > \nu_2 > \nu_3$ of incident radiation . Explain why the saturation current is independent of the anode potential.
6. What is the de Broglie hypothesis ? Show that a moving particle of kinetic energy E has de Broglie wavelength $\lambda = \frac{h}{\sqrt{2mE}}$.
7. Show that the de Broglie wavelength associated with an electron accelerated through a p.d. of V will be $\lambda = \frac{12.3}{\sqrt{V}} A^0$

NUMERICAL QUESTIONS

1. Calculate the threshold wavelength of radiation for emission of photoelectrons from a surface of work function 4.4 eV .
   [**Ans:** 281 nm]
2. What is de-Broglie wavelength of a 2 kg object with a speed of 3 m/s?
   [**Ans :** 1.1×10^{-34} m]
3. A radio transmitter operates at a frequency of 850 kHz and power of 10 kW . Find the number of photons emitted per second?
   [**Ans :** 1.72×10^{31}]

4. Light of wavelength 400 nm is incident on a cathode of photocell , the stopping potential recorded is 6 V . if the wavelength of incident light is increased to 600 nm , calculate the new stopping potential .
   [**Ans :** 4.97 V]
5. When a light of wavelength 400 nm falls on photosensitive surface the cut-off potential recorded is 1.8 V . What is the work function of this metal? If the wavelength of radiation is changed to 550 nm , what should be the value of cut-off potential?
   [**Ans :** 1.29 eV , 0.96 V]
6. The work function of caesium is 2.14 eV . Find (i) the threshold frequency for caesium and (ii) wavelength of incident light if the photocurrent is brought to zero by a stopping potential of 0.60 V.
   [**Ans :** (i) 5.164×10^{14} Hz , (ii) 4536 A^0]
7. Calculate the maximum kinetic energy of electrons emitted from a photosensitive surface of work function 3.2 eV , for the incident radiation of wavelength 300 nm.
   [**Ans :** 0.92 eV]
8. Calculate the de-Broglie wavelength of (i) an electron (in the hydrogen atom) moving with a speed of $\frac{1}{100}$ of the speed of light in vacuum and (ii) a ball of radius 5 nm and mass 3×10^{-2} kg. moving with a speed of 100 ms^{-1}. Hence show that the wave nature of matter is important at the atomic level but is not really relevant at the macroscopic level.
   [**Ans :** (i) 2.4 A^0 (ii) 2.21×10^{-34} m]

Note : if any mistake on this, kindly inform on the mail id :

bknal1207@gmail.com

Your Observation! Our Correction !!