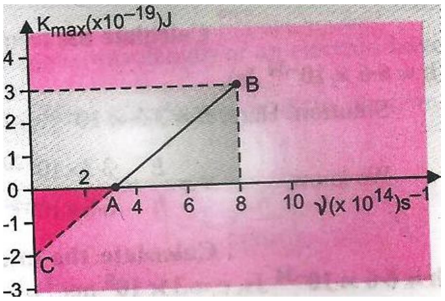
1. The threshold frequency for a certain metal is 3.3 x 10^{14}Hz. If light of frequency 8.2 x 10^{14}Hz is incident on the metal, predict the cut off voltage for photoelectric emission. Given h=6.63 x 10^{-34}Js, e = 1.6 x 10^{-19}C.

   Ans. 2.03V

2. The work function for cesium 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 of the emitted electrons ?

   Ans. 4.9 x 10^5 ms^{-1}

3. In an experiment on photoelectric effect, the graph between maximum kinetic energy (Kmax) and frequency v of emitted photoelelectron from metal surface is found to be a straight line as shown in figure. Calculate



   a. threshold frequency

   c. Planck's constant and

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

   a. v_0= 3 x $10^{14}s^{-1}$

   b. 1.25eV

   c. 6.0 x 10^{-34}Js

   d. 3 x 10^{-19}J

4. Two metals A and B have work functions 2 eV and 5 eV respectively. Which metal has lower threshold wavelength ?

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

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

7. A photon and electron have got same de-Broglie wavelength. Which has greater total energy ? Explain.

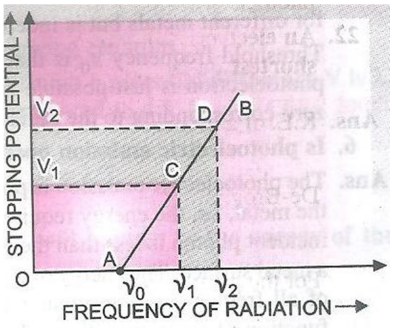
8. A Photon and electron have got same de-Broglie wavelength ($\approx 10^{-10}$m) which has greater kinetic energy ? Explain.

9. A Proton and an electron have same de-Broglie wavelength which of them moves fast and which possesses more K.E. Justify your answer.

10. Proton and alpha particles have same K.E. which one has greater de-Broglie wavelength ? Explain.

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

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



13. 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) existence of a threshold frequency for a given photoemitter.

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

15. Ultraviolet light is incident on two photosensitive materials having work functions w_1 and w_2 ($w_1 > w_2$). In which case will the K.E. of the emitted electrons be greater ? Why ?

16. An electron and a photon each have a wavelength of 2nm. Find

    a. their momenta

    b. The energy of the photon

    c. the kinetic energy of the electron.

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18. a. Ultraviolet light of wavelength 2271Å from a 100W mercury source is incident on a photocell made of molybdenum metal. If the stopping potential is 1.3V, estimate the work function of the metal.

    b. How would the photocell respond to high intensity ($10^5 Wm^{-2}$) red light of wavelength 6328 Å produced by a He-Ne laser ?

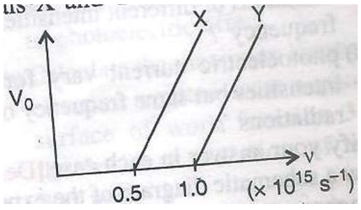
19a. Determine the de Broglie wavelength of a proton whose kinetic energy is equal to the rest mass energy of an electron. Mass of a proton 1836 times that of electron.

b. In which region of electromagnetic spectrum does this wavelength lie ?

20. A proton and an alpha particle are accelerated through the same potential. Which one of the two has (i) greater value of the de Broglie wavelength associated with it, and (ii) less kinetic energy ? Justify your answers.

21. An electromagnetic wave of wavelength λ is incident on a photosensitive surface of negligible work function. If the photo-electrons emitted from this surface have the de Broglie wavelength λ_1 prove that $\lambda = \left(\frac{2m}{h}\right)\lambda_1^2$.

22. The following graph shows the variation of stopping potential V_0 with the frequency v of the incident radiation for two photosensitive metals X and Y:

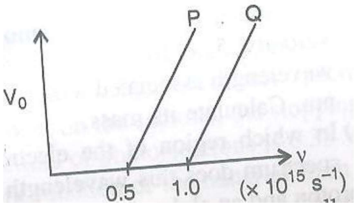


a.Which of the metal has larger threshold wavelength ? Give reason.

b. Explain, giving reason, which metal gives out electrons, having larger kinetic energy, for the same wavelength of the incident radiation.

c. if the distance between the light source and metal X is halved, how will the kinetic energy of electrons emitted from it change ? give reason.

23. The following graph shows the variation of stopping potential V_0 with the frequency v of the incident radiation for two photosensitive metals P and Q.



a. Explain which metal has smaller threshold wavelength.

b. Explain, giving reason, which metal emits photo-electrons having smaller kinetic energy.

c.If the distance between the light source and metal P is doubled, how will the stopping potential change ?

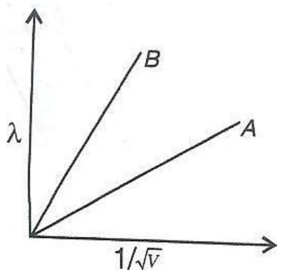
24. The ground state energy of hydrogen atom is -13.6eV. The photon emitted during the transition of electron from n = 2 to n =1 state, is incident on a photosensitive material of unknown work function. The photoelectrons are emitted from the materials with a maximum kinetic energy of 8eV. Calculate the threshold wavelength of the material used.

25. Draw the graphs showing the variation of photoelectric current with anode potential of a photocell for (i) the same frequencies but different intensities $I_1 > I_2 > I_3$ of incident radiation, (ii) the same intensity but difference frequency $v_1 > v_2 > v_3$ of incident radiation. Explain why the saturation current is independent of the anode potential.

26. When a surface 1 cm thick is illuminated with light of wavelength λ, the stopping potential is V_0, but when the same surface is illuminated by light of wavelength 3λ, the stopping potential is $\frac{V_0}{6}$. Find threshold wavelength for metallic surface.

27.Define the term 'work function' of a metal. The threshold frequency of a metal of 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 by $5f_0$,the maximum velocity of electrons emitted is v_2.Find the ratio of v_1 to v_2.

28. Obtain the expression for the wavelength of de Broglie wave associated with an electron accelerated from rest through a potential difference V. The two lines A and B shown n the graph plot the de Broglie wavelength (λ) as a function of $1/\sqrt{v}$ (v is the accelerating potential) for two particles having the



same charge. Which of the two represents the particle of heavier mass ?

29. Red light, however bright it is, can not produce the emission of electrons from a clean zinc surface. But even weak ultraviolet radiation can do so. Why ?

    X-rays of wavelength 'λ' fall on a photosensitive 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 $\sqrt{\frac{h\lambda}{2mc}}$.

30. Why are de Broglie waves associated with a moving football not visible ? 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.

31. 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 red end of the visible spectrum. In our experiment with rubidium photocell, the following lines from a mercury source were used ;

    λ_1=3650Å, λ_2=4047Å, λ_3=4358Å, λ_4=546Å, λ_5=6907Å, The stopping voltages, respectively, where measured to b ;

    V_{01}=1.28V, V_{02}=0.95V, V_{03}=0.74V,

    V_{04}=0.16V, V_{05}=0V.

    Determine the value of Planck's constant h, the threshold frequency and work function for the material.

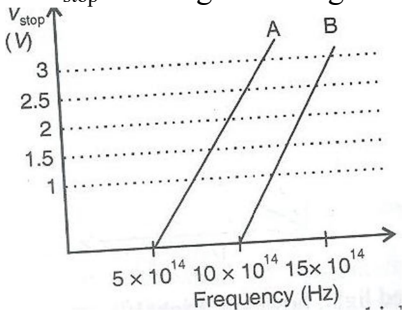
32. The work function of caesium metal is 2.14eV. When light of frequency 6 x 10^{14}Hz is incident on the metal surface, photoemission of electrons occurs. What is the

    a. Maximum kinetic energy of the emitted electrons.

    b. Stopping potential, and

    c. maximum speed of the emitted photoelectrons ?

33. A student performs an experiment on photoelectric effect, using two materials A and B. a plot of V_{stop} vs v is given in figure.



    a. Which material A and B has a higher work function ?

Given the electric charge of an electron = $1.6\ 10^{-19}$C, Find the value of h obtained from the experiment for both A and B. Comment on whether it is consistent with Einstein's energy.

34. Light of frequency 1.5times the threshold frequency is incident on a photosensitive material. If the frequency is halved and intensity is double, what happens to photoelectric current ?

35. Work functions of three elements A, B and C are is given below;

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

    A radiation of wavelength 4125 Å is made to be incident on each of these elements. By appropriate calculations show in which case photoelectrons will not be emitted.

36. A source of light of frequency $v > v_0$ is placed at 2 m from the cathode of a photocell. The stopping potential is found to be V_0. If the distance of the light source is halved, state with reason what changes occur in

    a. stopping potential

    b. photoelectric current, and

    c. Maximum velocity of photoelectrons emitted.

37. If the frequency of incident light on a metal surface is doubled for the same intensity, what change would you observe in;

    a. K.E. of photoelectrons emitted

    b. Photoelectric current and

    c. stopping potential

    justify your answer in each case.