EKLAVYA BATCH
THE GURUKUL INSTITUTE

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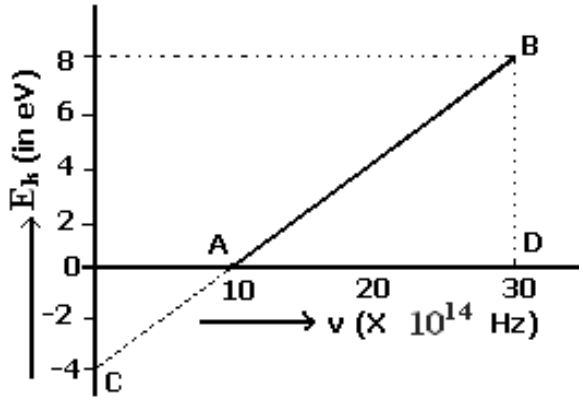
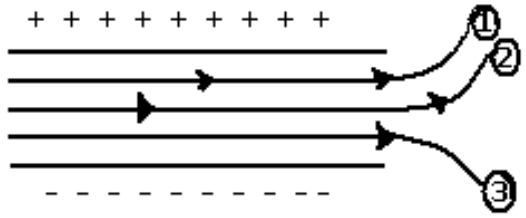
DUAL NATURE OF MATTER AND RADIATION

1. With what purpose was famous Davisson-Germer experiment with electrons performed?
2. De-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be its wavelength when the accelerating potential is increased to 4V?
3. Electrons are emitted from a photosensitive surface when it is illuminated by green light but electron emission does not take place by yellow light. Will the electrons be emitted when the surface is illuminated by: (i) red light, and (ii) blue light?
4. Does the 'stopping potential' in photoelectric emission depend upon
   a. The intensity of the incident radiation in a photocell?
   b. The frequency of the incident radiation?
5. Ultraviolet light is incident on two photopositive materials having work functions W_1 and W_2 ($W_1 > W_2$). In which case will the kinetic energy of the emitted electrons be greater? Why?
6. Show graphically how the stopping potential for a given photosensitive surface varies with the frequency of the incident radiation.
7. Define the work function for a given metallic surface.
8. Two metals A and B have work functions 2eV and 5eV respectively. Which metal has lower threshold wavelength?
9. The frequency (ν) of incident radiation is greater than threshold frequency (ν_0)in a photocell. How will the stopping potential vary if frequency (ν) is increased, keeping other factors constant?
10. If the intensity of the incident is increased, how does the stopping potential vary?
11. How does the maximum kinetic energy of electrons emitted vary with the work function of the metal?
12. If the maximum kinetic energy of electrons emitted in a photocell is 5eV, what is the stopping potential?
13. The work function of lithium is 2.3eV. What does it mean? What is the relation between the work function 'W' and the threshold wavelength 'λ' of a metal?
14. A source of light is placed at a distance of 50 cm from a photocell and the cut-off potential is found to be V_0.If the distance between the light source and photocell is made 25 cm, what will be the new cut-off potential ? Justify your answer.
15. Given below is the graph between frequency (ν_0) of the incident light and maximum kinetic energy (E_k) of emitted photoelectrons. Find the values of (i) threshold frequency (ii) work function from the graph.

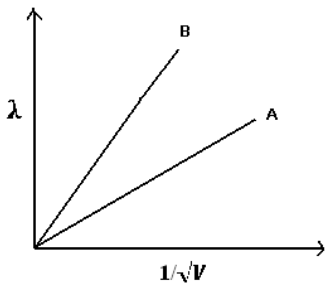


16. Green light ejects photoelectrons from a given photosensitive surface whereas yellow light does not. What will happen in case of violet and red light? Give reason for your answer.

17. An α- particle and a proton ar accelerated through the same potential difference. Calculate the ratio of velocities acquired by the two particles.
18. Figure below shows tracks of three charged particles 1, 2 and 3 in a uniform electric field. Give the signs of the three charges. Which particle has highest charge to mass ratio?



19. Define the terms threshold frequency and stopping potential in relation to the phenomenon of photoelectric effect. How is the photoelectric current affected on increasing the (i) frequency (ii) intensity of the incident radiations and why?
20. Sketch the graphs showing the variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $\nu_0 > \nu_0'$ respectively.
    a. Which of the two metals A and B has higher work function?
    b. What information do you get from the slope of the graphs?
    c. What does the value of the intercept of graph 'A' on the potential axis represents?
21. The threshold frequency of a metal is f_0. When the light of frequency $2f_0$ *is* incident on the metal plate, the maximum velocity of electrons emitted is ν_1. When the frequency of the incident radiation is increased to $5f_0$, the maximum velocity of electrons emitted is ν_1. Find the ratio of ν_1 to ν_2.
22. 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 in the graph plot the de-Broglie wavelength ($\boldsymbol{\lambda}$) 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?



23. Why are de-Broglie waves associated with a moving football not visible? The wavelength $\boldsymbol{\lambda}$, 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, whereas m, c and h have their usual meanings.
24. a. An electron beam passes through a region of crossed electric and magnetic fields of intensities E and B respectively. For what value of electron speed will the beam remain undeflected?
    b. A beam of α- particles and of protons, of the same velocity v, enters a uniform magnetic field at right angles to the field lines. The particles describe circular paths. Calculate the ratio of the two paths.

25. What is photoelectric effect? Write Einstein's photoelectric equation and use it to explain
    a. Independence of maximum energy of emitted photoelectrons from intensity of incident light.
    b. Existence of a threshold frequency for emission of photoelectrons.
26. 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
    c. Stopping potential
    Justify your answer in each case.
27. Derive the expression for the de-Broglie wavelength of an electron moving under a potential difference of V volt.
    Describe Davisson and Germer experiment to establish the wave nature of electrons. Draw a labeled diagram of the apparatus used.
28. Red light however bright, cannot cause emission of electrons from a clean zinc surface. But even weak ultraviolet radiations can do so. Why? Draw the variation of maximum kinetic energy of emitted electrons with the frequency of incident radiation on a photosensitive surface. On the graph drawn, what do the following indicate (i) slope of the graph and (ii) intercept on energy axis?
29. Explain the term: 'stopping potential' and 'threshold frequency' in photoelectric emission. Draw a graph showing the variation of stopping potential with frequency of incident light in relation to photoelectric effect. Deduce an expression for the slope of this graph using Einstein's photoelectric equation.