12.Dual Nature of Matter & Radiation

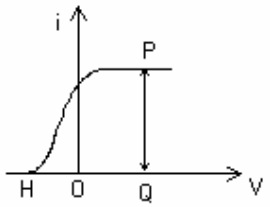
1. a) Sodium has a work function of 2.0 eV. Calculate the maximum energy and speed of the emitted electrons when sodium is illuminated by radiation of wavelength 150 nm.

   b) What is the least frequency of incident radiation (threshold frequency)that can emit electrons? ($h = 6.6\times10^{-34}$ J.s; $e = 1.6\times10^{-19}$c, $M_e = 9.1\times10^{-31}$kg, $c = 3\times10^{8}$ ms^{-1}).

2. Caesium has a work function of 1.9 eV. Find
   (i) its threshold wavelength
   (ii) the maximum energy of the liberated electrons when the metal is illuminated by light of wavelength 4.5×10^{-7} m.
   (iii) stopping potential.

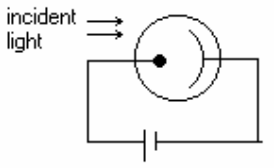
3. Current I against p.d. V for a photographic cell when a beam of monochromatic light illuminates the cathode and the photoelectrons are collected by the anode.
   Which of the following is correct when light is replaced by another monochromatic light of greater intensity and greater wavelength?

   (i) PQ unchanged, OH increases
   (ii) PQ decreases, OH increases
   (iii) PQ increases, OH decreases
   (iv) PQ increases, OH increases
   (v) PQ decreases, OH increases



4. Photoelectrons are emitted by C when illuminated by a beam L of monochromatic light and collected by A. Which of the following statements are correct?

   The maximum energy of the emitted electron is
   1. proportional to the intensity of L
   2. increases when V is greater
   3. increases when the inverse of wavelength increases

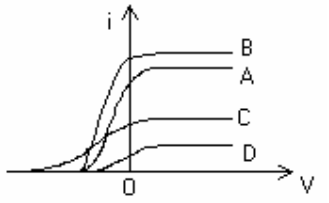


5. When electromagnetic radiation falls on a metal surface, electrons may be emitted. This is the photoelectric effect.

   (i) State Einstein's photoelectric equation, explaining the meaning of each term.
   (ii) Explain why, for a particular metal, electrons are emitted only when the frequency of the incident radiation is greater than a certain value.
   (iii) Explain why the maximum speed of the emitted electrons is independent of the intensity of the incident radiation.

6. When light of frequency 5.4×10^{14} Hz is shone on to a metal surface, the maximum energy of the electrons emitted is 12×10^{-19} J. If the same surface is illuminated with light of frequency 6.6× 1014 Hz, the maximum energy of the electrons emitted is 2.0× 10^{-19}. Find the value of Planck constant.

7. A. Emissive material is illuminated with monochromatic light of wavelength λ.
   B. As A, but the intensity of light has been changed
   C. As A, but the wavelength of light has been changed
   D. As A, but the emissive material is different.
   Explain the general form of curve A.
   In what ways do curves B, C, D: (i) resemble A;
   (ii) differ from A?
   What explanation of the difference can be offered?



8. From the graph answer the following questions:
   i. What is the frequency below which no electrons are emitted?
   ii. When the following is 5.5×10^{14} Hz, the required stopping voltage is 0.43 V. Estimate the kinetic energy of the fastest moving electrons emitted by light of this frequency.
   iii. Use the graph to find a value for Planck constant.
   iv. Explain the effect, if any, of increasing the intensity of light on the experimental observations and on the graph.