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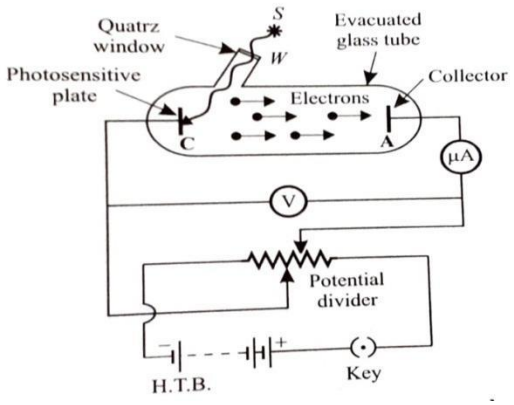
CLASS XII CBT NOVEMBER 2023 , SUBJECT- PHYSICS

TOPIC- DUAL NATURE OF MATTER AND ATOMS

CASE STUDY-1 : Read the following paragraph and answer the correct option of MCQ



The experimental arrangement used for the study of photoelectric effect is shown in the figure. It consists of an evacuated glass/quartz tube which encloses a photosensitive plate C and another metal plate A. A relative potential may apply by a potential divider. On the basis of the experimental results on photoelectric effect, Lenard and Millikan gave the following laws of photoelectric emission:

- **At a particular fixed frequency of incident radiation above threshold frequency, the rate of the emission of photoelectrons i.e. the photocurrent increases with increase in the intensity of the incident light.**
- **Photo electric effect does not occur at frequency less than threshold frequency.**
- **At the frequency above the threshold frequency, the kinetic energy of the ejected electrons depends only on the frequency of the exposed radiation and not on its intensity.**
- **There is no time lag between the irradiation of the surface and the ejection of the electrons.**

1. Photoelectric emission occurs for a photosensitive surface, of threshold wavelength λ_0, if the wavelength λ of incident radiation is

(a) more than λ_0 (b) less than λ_0 (c) do not depends on λ_0 (d) is equal to λ_0

Ans: (b) Less than λ_0:

As we know that photoelectric emission takes place when frequency of incident radiation is greater than that of threshold frequency and the relation of frequency and wavelength is given by $c = \lambda\nu$ and from this relation it is clear that $\nu = \frac{1}{\lambda}$.

2. If the intensity of incident radiation increases, whose frequency greater than critical frequency ν_0 then

(a) Number of photo electrons increases (b) K.E. of photo electrons increases (c) magnitude of stopping potential increases (c) maximum K.E. of photo electron increases.

Ans: - (a) Number of photo electrons increases:

As we know that intensity of radiation is directly proportional to number of photons incident of the surface. Photoelectric emission is a one to one process which means one photon emits only one electron. Therefore, increase in intensity of radiation means more number of photons is getting incident on the surface which result in more electrons to be emitted.

3. If frequency ν of incident radiation increases (where $\nu > \nu_0$) then

(a K.E. of photo electrons decreases (b) stopping potential of photo electron decreases (c) No effect on K. E. of photo electron (d) K.E. of photo electrons increases.

Ans: - from photo electric equation we know that $K.E. = h(\nu - \nu_0)$. So the increase in frequency of incident radiation increases the kinetic energy of photo electrons.

4. The strength of photoelectric current is directly proportional to:

(a) Frequency of incident radiation (b) Intensity of incident radiation (c) Angle of incidence of radiation (d) Distance between anode and cathode.

Ans: - (b) Intensity of incident radiation:

Photoelectric current strength depends on number of photoelectrons emitted and photoelectron emission depends on intensity of incident radiation.

CASE STUDY-2 :Read the following paragraph and answer the correct option of MCQ

The model of the atom proposed by Rutherford assumes that the atom, consisting of a central nucleus and revolving electron is stable much like sun-planet system which the model imitates. However, there are some fundamental differences between the two situations. While the planetary system is held by gravitational force, the nucleus-electron system being charged objects, interact by Coulomb's Law of force. We know that an object which moves in a circle is being constantly accelerated – the acceleration being centripetal in nature. According to classical electromagnetic theory, an accelerating charged particle emits radiation in the form of electromagnetic waves. The energy of an accelerating electron should therefore, continuously decrease. The electron would spiral inward and eventually fall into the nucleus. Thus, such an atom cannot be stable. Further, according to the classical electromagnetic theory, the frequency of the electromagnetic waves emitted by the revolving electrons is equal to the frequency of revolution. As the electrons spiral inwards, their angular velocities and hence their frequencies would change continuously, and so will the frequency of the light emitted. Thus, they would emit a continuous spectrum, in contradiction to the line spectrum actually observed. Clearly Rutherford model tells only a part of the story implying that the classical ideas are not sufficient to explain the atomic structure. It was Niels Bohr (1885 – 1962) who made certain modifications in this model by adding the ideas of the newly developing quantum

hypothesis. Niels Bohr studied in Rutherford's laboratory for several months in 1912, Bohr, in 1913, concluded that a fairly radical departure from the established principles of classical mechanics and electromagnetism would be needed to understand the structure of atoms and the relation of atomic structure to atomic spectra. Bohr combined classical and early quantum concepts and explained the structure of atom and its stability.

5. **In terms of Bohr radius r_0 , what is the radius of second orbit of hydrogen atom?**
   a) $9r_0$
   b) $4r_0$
   c) $2r_0$
   d) $\sqrt{2}r_0$

Ans: - We know that $r = n^2 r_0$. Hence (b) is the correct answer.

6. **The kinetic energy of electron in the first excited state is 3.4 eV. What is its potential energy in this state?**
   a) **-3.4eV**
   b) **6.8 eV**
   c) **- 6.8 eV**
   d) **3.4 eV**

Ans: - We know that $U = -2(K.E.)$. (c) -6.8 eV is correct answer.

7. **What is the longest wavelength of Balmer series of hydrogen spectrum?**
   a) **6557** Å
   b) **1216** Å
   c) **4335** Å
   d) **7468** Å

Ans: - Balmer series expends from 365 nm to 656 nm. So the correct answer is (a).

8. **The angular momentum of an electron in the second excited state of hydrogen atom?**
   a) $\frac{h}{2\pi}$
   b) $\frac{3h}{2\pi}$
   c) $\frac{h}{\pi}$
   d) $\frac{nh}{2\pi}$

Ans: - second excited state means n = 3 and from Bohr's Second postulate $L = \frac{nh}{2\pi}$. So correct answer is (b).

ASSERTION REASON TYPE QUESTION

Directions: These questions consist of two statements, Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses. (a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion. (b) If both Assertion and Reason are correct but Reason is not a

correct explanation of the Assertion. (c) If the Assertion is correct but Reason is incorrect. (d) If both the Assertion and Reason are incorrect

9. **ASSERTION:** In photoelectric effect, at stopping potential emission of photoelectrons is stopped,
   REASON: Increases in the intensity of given light increases the K.E of photo electrons
   Answer: - (c) Assertion is correct whereas reason is false. Stopping potential depends on frequency of radiation than that of intensity.
10. **ASSERTION**: An electron in hydrogen atom transits from n= 3 to n= 1 level. The maximum number of photons emitted is 3. .
    REASON: The number of photons emitted can be calculated by using expression $\frac{n(n-1)}{2}$.
    Answer: - number of photons = 3(3-1)/2 = 3x2/2 = 3.
