

Practice Questions– Photoelectric Effect & de Broglie Wavelength

JEE Mains Assignment

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Instructions:

- This assignment contains **15 questions**.
- Questions 1–10 are **Single Correct Answer** (MCQ).
- Questions 11–13 are **Numerical Value Type** (Integer 0–999).
- Questions 14–15 are **Assertion-Reason** type.
- All values use standard constants: $h = 6.63 \times 10^{-34}$ J·s, $c = 3 \times 10^8$ m/s, $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C, $hc = 1240$ eV·nm.

Section A: Single Correct Answer (1–10)

- Q.1** The de Broglie wavelengths of a proton and an α -particle are λ and 2λ respectively. The ratio of the velocities of proton and α -particle will be:
- (A) 1 : 8
(B) 8 : 1
(C) 4 : 1
(D) 1 : 4
- Q.2** When a metal surface is illuminated by light of wavelength λ , the stopping potential is 8 V. When the same surface is illuminated by light of wavelength 3λ , the stopping potential is 2 V. The threshold wavelength for this surface is:
- (A) 2λ
(B) 3λ
(C) 4λ
(D) 5λ
- Q.3** An α -particle and a proton are accelerated from rest by the same potential difference. The ratio of their de Broglie wavelengths $\left(\frac{\lambda_p}{\lambda_\alpha}\right)$ is:
- (A) $2\sqrt{2}$
(B) $\frac{1}{2\sqrt{2}}$
(C) $\frac{1}{\sqrt{2}}$

(D) $\sqrt{2}$

Q.4 In a photoelectric effect experiment, light of frequency 1.5 times the threshold frequency is made to fall on a photosensitive material. Now if the frequency is halved and intensity is doubled, the number of photoelectrons emitted will be:

- (A) Doubled
- (B) Halved
- (C) Zero
- (D) Same as before

Q.5 A particle moving with kinetic energy E has de Broglie wavelength λ . If energy ΔE is added to its energy, the wavelength becomes $\lambda/2$. The value of ΔE is:

- (A) E
- (B) $2E$
- (C) $3E$
- (D) $4E$

Q.6 The work function of a metal is 3.0 eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately:

- (A) 200 nm
- (B) 414 nm
- (C) 540 nm
- (D) 600 nm

Q.7 An α -particle, a proton and an electron have the same kinetic energy. Which one of the following is correct regarding their de Broglie wavelengths?

- (A) $\lambda_\alpha = \lambda_p = \lambda_e$
- (B) $\lambda_\alpha < \lambda_p < \lambda_e$
- (C) $\lambda_\alpha > \lambda_p > \lambda_e$
- (D) $\lambda_\alpha = \lambda_p > \lambda_e$

Q.8 When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to:

- (A) 0.62 eV
- (B) 1.24 eV
- (C) 1.55 eV
- (D) 2.48 eV

Q.9 Electron beam used in an electron microscope, when accelerated by a voltage of 20 kV, has a de Broglie wavelength of λ_0 . If the voltage is increased to 40 kV, then the de Broglie wavelength associated with the electron beam would be:

- (A) $\sqrt{2} \lambda_0$
- (B) $\frac{\lambda_0}{\sqrt{2}}$
- (C) $2\lambda_0$
- (D) $\frac{\lambda_0}{2}$

- Q.10** A metal surface is illuminated by a radiation of wavelength 4500 \AA . The ejected photoelectron enters a constant magnetic field of 2 mT making an angle of 90° with the magnetic field. If it starts revolving in a circular path of radius 2 mm , the work function of the metal is approximately:
- (A) 1.2 eV
 - (B) 2.1 eV
 - (C) 0.9 eV
 - (D) 1.8 eV

Section B: Numerical Value Type (11–13)

- Q.11** The de Broglie wavelength of an oxygen molecule at 27°C is $x \times 10^{-12} \text{ m}$. The value of x is:
(Given: $k_B = 1.38 \times 10^{-23} \text{ J/K}$, mass of O_2 molecule = $5.31 \times 10^{-26} \text{ kg}$)
- Q.12** The ratio of de Broglie wavelength of an α -particle and a proton accelerated from rest by the same potential is $\frac{1}{\sqrt{m}}$. The value of m is:
- Q.13** A 2 mW laser operates at a wavelength of 500 nm . The number of photons emitted per second is $N \times 10^{15}$. The value of N is:
(Given: $h = 6.6 \times 10^{-34} \text{ J}\cdot\text{s}$)

Section C: Assertion-Reason (14–15)

- Q.14 Assertion (A):** The photoelectric effect demonstrates the particle nature of light.
Reason (R): In the photoelectric effect, light behaves as a wave because the energy of emitted electrons depends on the intensity of incident light.
- (A) Both A and R are true and R is the correct explanation of A.
 - (B) Both A and R are true but R is NOT the correct explanation of A.
 - (C) A is true but R is false.
 - (D) A is false but R is true.
- Q.15 Assertion (A):** The de Broglie wavelength of a gas molecule varies inversely as the square root of absolute temperature.
Reason (R): The root mean square velocity of gas molecules is directly proportional to the square root of absolute temperature.
- (A) Both A and R are true and R is the correct explanation of A.
 - (B) Both A and R are true but R is NOT the correct explanation of A.
 - (C) A is true but R is false.
 - (D) A is false but R is true.