

Dual Nature of Radiation and Matter — Assignment 1

Class 12 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Photoelectric Effect

MCQ Questions (choose the correct option)

- The photoelectric effect demonstrates the
 - particle nature of light
 - wave nature of light
 - polarisation of light
 - dispersion of light
- The work function of a metal is the
 - minimum energy needed to eject an electron
 - maximum kinetic energy of an electron
 - threshold frequency
 - stopping potential
- The photoelectric current is proportional to the
 - intensity of incident light
 - frequency of incident light
 - work function
 - stopping potential
- Photoelectric emission occurs only when the incident frequency is
 - greater than the threshold frequency
 - less than the threshold frequency
 - equal to zero
 - independent of threshold

1 Mark Questions

- What is the photoelectric effect?
- What is the work function of a metal?
- State the relation between the maximum kinetic energy of a photoelectron and the stopping potential.

2 Mark Questions

- State the laws of photoelectric emission.
- The threshold wavelength of a metal is 500 nm. Find its work function. (Ans: 2.48 eV)

3 Mark Questions

- Describe the experimental study of the photoelectric effect and state its laws.
- Explain how the photoelectric effect establishes the particle nature of light.

Einstein's Photoelectric Equation

MCQ Questions (choose the correct option)

1. Einstein's photoelectric equation is
 - (A) $h\nu = \phi_0 + K_{\text{max}}$
 - (B) $h\nu = \phi_0 - K_{\text{max}}$
 - (C) $h\nu = \phi_0 \times K_{\text{max}}$
 - (D) $h\nu = K_{\text{max}} / \phi_0$
2. The stopping potential V_0 is related to K_{max} by
 - (A) $K_{\text{max}} = eV_0$
 - (B) $K_{\text{max}} = V_0/e$
 - (C) $K_{\text{max}} = e/V_0$
 - (D) $K_{\text{max}} = V_0$
3. The threshold frequency is given by
 - (A) ϕ_0/h
 - (B) h/ϕ_0
 - (C) $h\phi_0$
 - (D) $\phi_0 h$
4. Increasing the intensity of incident light (above threshold) increases the
 - (A) number of photoelectrons
 - (B) kinetic energy of photoelectrons
 - (C) threshold frequency
 - (D) work function

1 Mark Questions

1. Write Einstein's photoelectric equation.
2. What is threshold frequency?
3. Write the equation for the maximum kinetic energy in terms of stopping potential.

2 Mark Questions

1. Write Einstein's photoelectric equation and explain each term.
2. Light of wavelength 400 nm falls on a metal of work function 2 eV. Find the maximum kinetic energy of the emitted electrons. (Ans: ≈ 1.1 eV)

3 Mark Questions

1. State Einstein's photoelectric equation and use it to explain the laws of photoelectric emission.
2. Derive Einstein's photoelectric equation and explain the terms threshold frequency, work function and stopping potential.

Stopping Potential and Graphs**MCQ Questions (choose the correct option)**

1. The stopping potential depends on the
 - (A) frequency of light
 - (B) intensity of light
 - (C) distance of source
 - (D) area of the metal

2. A graph of K_{max} against frequency is a straight line whose slope is
 - (A) Planck's constant h
 - (B) the work function
 - (C) the threshold frequency
 - (D) e/h
3. The intercept of the $K_{\text{max}}-v$ graph on the frequency axis gives the
 - (A) threshold frequency
 - (B) work function
 - (C) stopping potential
 - (D) Planck's constant
4. The photocurrent–voltage graph shows that the saturation current is proportional to
 - (A) intensity
 - (B) frequency
 - (C) work function
 - (D) wavelength

1 Mark Questions

1. What is stopping potential?
2. What does the slope of the K_{max} vs frequency graph represent?
3. What does the intercept on the frequency axis of the $K_{\text{max}}-v$ graph give?

2 Mark Questions

1. Draw a graph of photocurrent versus collector potential and explain the saturation current and stopping potential.
2. Draw and explain the graph of maximum kinetic energy versus frequency of incident light.

3 Mark Questions

1. Draw the graphs of (i) photocurrent vs potential and (ii) K_{max} vs frequency, and explain what each part of the graph shows.
2. Explain, using graphs, how the stopping potential and the maximum kinetic energy vary with the frequency and intensity of incident light.

Wave Nature of Matter — de Broglie

MCQ Questions (choose the correct option)

1. The de Broglie wavelength of a particle of mass m moving with velocity v is
 - (A) h/mv
 - (B) mv/h
 - (C) hmv
 - (D) $h/(m+v)$
2. The de Broglie wavelength of an electron accelerated through potential V is proportional to
 - (A) $1/\sqrt{V}$
 - (B) $\sqrt{V}$
 - (C) V
 - (D) $1/V$
3. The de Broglie hypothesis states that

- (A) matter has wave properties
 - (B) light has wave properties
 - (C) electrons are stationary
 - (D) photons have mass
4. For a particle of kinetic energy E , the de Broglie wavelength is
- (A) $h/\sqrt{2mE}$
 - (B) $\sqrt{2mE}/h$
 - (C) $h/(2mE)$
 - (D) $2mE/h$

1 Mark Questions

1. State the de Broglie hypothesis.
2. Write the expression for the de Broglie wavelength of a particle.
3. Write the de Broglie wavelength of an electron accelerated through a potential V .

2 Mark Questions

1. Calculate the de Broglie wavelength of an electron accelerated through a potential of 100 V. (Ans: $\approx 1.23 \times 10^{-10}$ m)
2. Find the de Broglie wavelength of an electron moving with a speed of 10^6 m/s. (Ans: $\approx 7.3 \times 10^{-10}$ m)

3 Mark Questions

1. State the de Broglie hypothesis and derive the expression for the de Broglie wavelength of a charged particle accelerated through a potential difference.
2. What is the de Broglie wavelength? Derive its expression for (i) a particle of mass m and kinetic energy E and (ii) an electron accelerated through a potential V .

Davisson-Germer Experiment

MCQ Questions (choose the correct option)

1. The Davisson-Germer experiment demonstrated the
 - (A) wave nature of electrons
 - (B) particle nature of light
 - (C) photoelectric effect
 - (D) existence of the nucleus
2. In the Davisson-Germer experiment, electrons are diffracted by
 - (A) a nickel crystal
 - (B) a glass prism
 - (C) a single slit
 - (D) a diffraction grating
3. The Davisson-Germer experiment provides direct verification of
 - (A) de Broglie's hypothesis
 - (B) Newton's laws
 - (C) Bohr's model
 - (D) the photoelectric effect
4. The diffracted electron beam shows maximum intensity in the direction
 - (A) of constructive interference

- (B) of destructive interference
- (C) of reflection only
- (D) randomly

1 Mark Questions

1. What did the Davisson-Germer experiment demonstrate?
2. Which hypothesis does the Davisson-Germer experiment verify?
3. What is used to diffract electrons in the Davisson-Germer experiment?

2 Mark Questions

1. Describe the Davisson-Germer experiment and state its significance.
2. Explain how the Davisson-Germer experiment provides evidence for the wave nature of electrons.

3 Mark Questions

1. Describe the Davisson-Germer experiment, stating its results, and explain how the observed diffraction confirms the wave nature of electrons.
2. What is the Davisson-Germer experiment? Describe it and show how its results verify de Broglie's hypothesis.